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The Sidi Rached Masonry Bridge, Constantine, Algiers*

A masonry bridge of monumental size containing one of the large masonry arches of the world has recently been completed by the French Corps of Ponts et Chaussées, across the Rhumel River, at Constantine, Algiers. A lengthy description of this bridge, which is one of two large bridge structures just completed at this location, appears under the authorship of M. Boisnier, in the May-June, 1912, number of the *Annales des Ponts et Chaussées*. From that article we have prepared the following abstract.

The city of Constantine is located on both banks of the cañon cut by the river through the limestone rock of North Africa and has been the location of a town since early Roman days. The gorge, which must be crossed by some of the streets of the city, is narrow, with precipitous banks which rise as high as 200 ft. above the water level of the river and which slope back on gradual grades to the main level of the city. Across this whole depression one of the main thoroughfares of the town is carried on the bridge known as Sidi Rached Bridge, a view of which is shown on this page.

*This bridge was noted in a brief description, Engineering News, April 13, 1911, p. 451.

This structure consists of a series of masonry arches of varying span, thirteen of 28.9 ft. clear span, eight of 31.2 ft., four of 52.5 ft., one of 98.5 ft. and one of 227 ft., 27 in all, totaling 1468 ft. in length. In plan the viaduct comprises two curves, one of 164 ft. radius and one of 355 ft. radius with a connecting and two approach tangents. The curved portions are made up of the smallest span arches. There is a grade of 1.17% from one end of the bridge to the other. The width of the structure is 39.4 ft., made up of a 26.2 ft. roadway and two 6.6-ft. sidewalks.

THE SIDI RACHED MASONRY ARCH OVER THE RHUMEL RIVER AND GORGE, NEAR CONSTANTINE, ALGIERS
(Central arch, 227-ft. span.)

The design and construction of the smaller arches presented no extraordinary problems, but the large 227-ft. arch was built under the latest and best methods of those French engineers who of late years have done so much to perfect the large masonry arch. The construction of the arch ring and the design of the centering are particularly interesting and will be described in detail.

The main arch of the Sidi Rached Bridge has a clear span of 227 ft. and a rise of 82 ft. The intrados curve is the arc of a circle which would give a span of 230 ft. at the skewback except for the enlarged sections there, which reduce the span to 227 ft. The arch is in two twin ribs each 13.1 ft. wide at the crown with a side batter which enlarges them to 17.3 ft. at the skewback, and they are spaced 13.1 ft. apart at the crown. Each rib is 4.9 ft. thick at the crown, enlarging to about 10 ft. at the skewback, the extrados being also an arc of a circle. The roadway is carried on a reinforced-concrete slab spanning the spandrel walls and arches which rise from each rib. Except for the floor slab, the entire arch, in fact the entire bridge, is built of cut limestone quarried in the immediate vicinity of the structure.

The arch abutments are founded on the rock sides of the gorge. This rock contained a number of openings or grottoes made by erosion of acid-bearing waters, which in some places had to be filled up with concrete, but for the most part the footings were eminently satisfactory. The twin arch ribs permitted of the location of the footings at different elevations and thus saved considerable masonry.

The stone voussoirs were cut to designed shape for location at specified places in the rib and were laid up in a cement mortar. The regular voussoirs were placed with the usual mortar bedding, but those that formed keystones were blocked apart, as described below, and the mortar afterward rammed in.

Before construction, the contractor submitted a plan for laying up the arch ribs, and these rules, approved by the engineer, were followed on the work. The main portion of the rules is as follows:

Rules for Laying up Arch

The portions of the arch between the skewbacks and the points C_8 and C'_8 shall be laid up in full depth of arch. Between these points the arch shall be constructed in three rows. Before laying the stone the pattern of the separate voussoirs shall be laid out on the lagging of the forms and the respective location marked on the lagging.

The arch shall be constructed in three rows, having respectively the following thicknesses: First row, 0.4 E and 0.3 E, alternately, second row, 0.3 E, third row, 0.3 E, and 0.4 E alternately: E is the thickness of the arch.

At the points C_2, C_4, C_6, and their corresponding points on the other side of the arch, there shall be fixed a vertical angle block shown in detail in Fig. 2, in which the line AB is a line normal to the curve of the arch.

The arch shall then first be loaded with all the arch stone comprised within angle of 27° on either side of the vertical center axis of the arch. This will take up the space between the points C_4 and C'_4, and is placed to prevent the rising of the crown under the loading of the haunches.

The four first stones, Fig. 2, A, B, C and D of the sections I and I′ will next be laid. The stones A and D will be placed with the ordinary mortar backing but the stones B and C will be placed with wedges as is indicated in the drawing. The lead wedge will be a round bar, thickness of about ½ in., and the stones will be kept in proper position with the wooden wedges shown at the top. The upper part of the joint will then be filled with tow to keep out any extraneous matter. The upper part of this section will then be held with the blocking shown and the opening kept as the final keystone to be placed.

Following the construction of sections I and I′ the sections II, III and IV (symmetrically on both sides) will be built. These sections will be held with the blocking described before as shown in Fig. 2. At the juncture of the purlins, that is at points C_1, C_3, C_5, etc., a dry joint similar to the one shown at C_8 will be left.

This leaves seventeen keystones to be placed in the first or lower row. These will be executed from the crown in the order shown on the figure, proceeding symmetrically on either side of the arch. Above point C_2 the blocking may be taken down to make the key if the stones have been in place on either side of it for at least six days. At the other joint the blocking will be removed but bracing placed between the two sections while the Keystone is being set. The last keystones to be set are those at C_8 and C'_8.

After the keying of the first row no work shall be done on the masonry for eight days in order to allow the mortar to attain a certain degree of hardness to resist the weight of the other rows.

The second row shall be executed in eight sections, four on each side laid symmetrically. Below C_8 blocking shall be placed to hold the stone in place. Above C_4 the interlocking of the second row with the first will be sufficient to hold the stone in place. In this second row there will be seven keystones. In the construction of sections V and V′ there will be a dry joint left near the middle of the section which will be filled in the manner described for C_8.

After the finishing of the keying of the second row, the third row will be started. This is divided into eight sections placed simultaneously on either side. Below point C_6 the stones will be held in place with blocking. Above C_4 the interlocking of the stones will be sufficient. There are seven keystones in the third row. In the construction of sections IX and IX′ a dry joint will be left near the middle of the section which will be filled as the final operation.

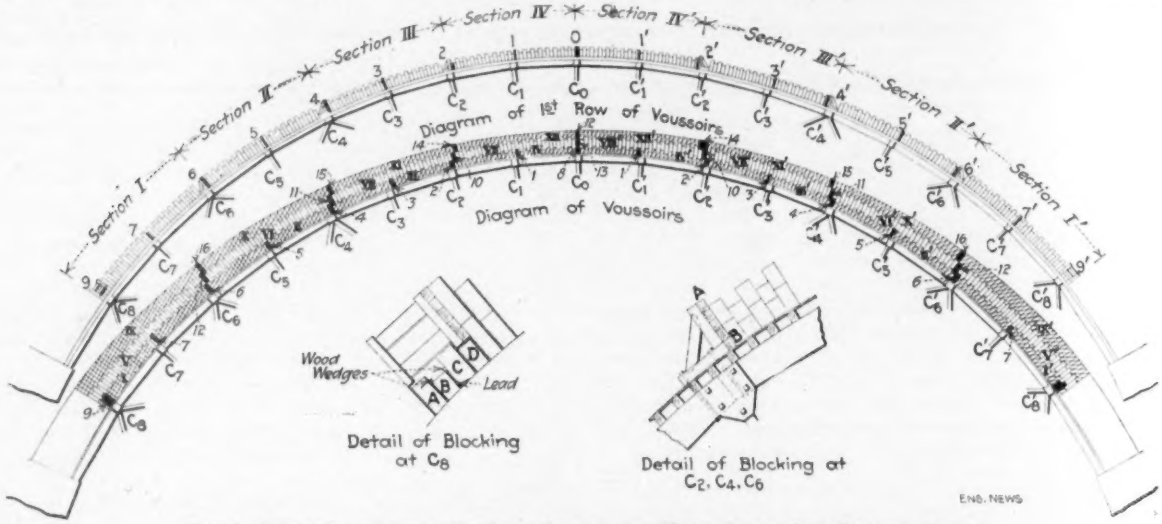


Fig. 2. Method of Laying Up Arch Stones on Main Arch, Sidi Rached Bridge

Under this method the keying of the arches was very successfully carried out, and no marked deflection of the centers was noted. Furthermore, after the lowering of the centers no cracks were noted between any of the voussoirs. A cement mortar was used between all joints, and in those dry joints which were filled afterwards as a key the filling was done by tamping the mortar in hard with a thin metal plate.

Centering for Main Arch

The great difficulty in constructing the large arch of the bridge lay in the centering, particularly on account of the depth and width of the gorge, which would not allow of any foundation for the falsework between the two abutments. The gorge at this point is nearly 200 ft. deep and the river is subject to high and violent floods which would prevent carrying down the falsework supports to the gorge bottom even if the great depth did not render that impracticable.

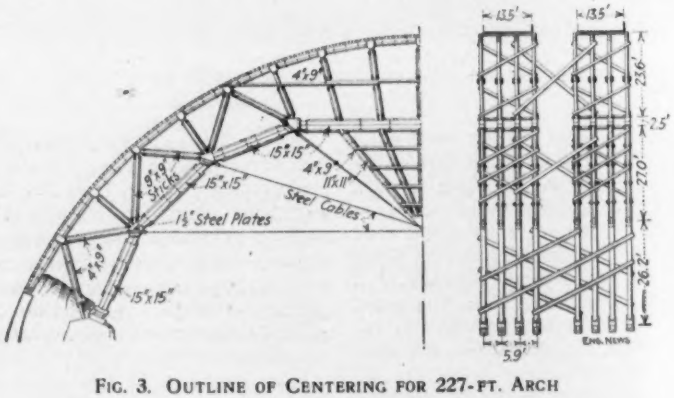


Fig. 3. Outline of Centering for 227-ft. Arch

It was at first intended to build a steel arch centering of 183 ft. span to be used for one arch rib and then moved over to

the other end, finally to be taken down and rerected as a permanent structure farther down the gorge. Difficulties in erecting this steel structure and particularly the difficulties to be expected in dismounting it for permanent use elsewhere, caused the engineers to devise another style of centering. This is shown in Figs. 3-6, and is after a design by M. Sejourné, the celebrated designer and builder of the Luxembourg and other large arches.

FIG. 4. METHOD OF ERECTING CENTERING

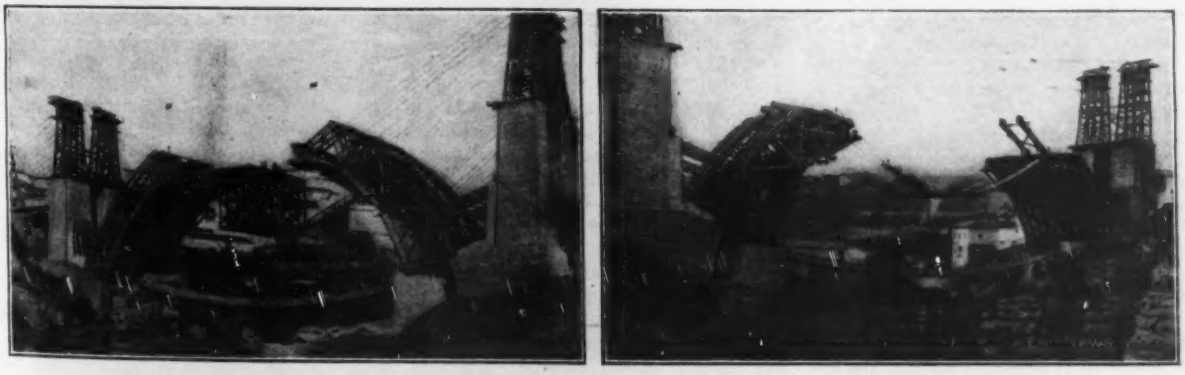
The centering adopted is a trussed timber arch erected by suspension from timber towers built on the incompleted piers of the main arch span. The stresses in the framing were figured on a direct transmission of the load of a thickness of arch ring of 3.3 ft. The thickness of the first row of voussoirs is 2 ft. at the crown and 4 ft. at the springing line.

It was at first thought best to build the centering for only one rib and to move it over to the twin rib when the first was set, but it was later considered that the single width would not be stiff enough to resist bending or twisting or to stand up against the high winds which blow through the gorge. The center was therefore built in two sections, one under each rib, thoroughly tied together with cross braces.

The centering, as shown in Fig. 3, consists of eight longitudinal rows of seven heavy oak sticks, reinforced with planks, arranged in the general form of an arch, cutting through the wood by metal pieces.

The erection of the centering was carried on from towers erected on the sides of the gorge and carrying traveling cableways for the transportation of men and materials. The two center lines of the truss centers were first erected and carried a panel or two ahead of the remainder of the falsework to be used as the basis for the erecting operation (see Fig. 6). As these arches were carried outward they were supported by cables tied back to the piers of the bridge and to the erection towers. When all but the center sticks of the arch truss were erected, an intermediate suspension structure was set up (Figs. 5 and 6) and on a platform hung from this the middle truss of the falsework was erected and swung into place. As soon as all of the parts of the centering were put together the suspending cables were removed and the arch took its own set on its abutments, ready for placing of masonry.

It so happened that the wood of the centering in drying out effected its own lowering, so that the hydraulic jacks provided at the skewbacks of the centering arch were not needed to strike the masonry arch. They were used, however, in the lowering of the falsework after it had served its purpose. It is reported that the falsework was remarkably stiff and stable and that it deflected only a negligible amount under the loading of



FIGS. 5-6. VIEWS SHOWING ERECTION OF CENTERING FOR SIDI RACHED ARCH

from skewbacks built up on either side of the gorge. This arch carries the lagging by a truss system and is held together by a heavy trussing under the middle stick and a system of cables. All joints are protected with heavy iron plates and the cables are prevented from the arch.

The whole viaduct, 1468 ft. in length, cost, in round numbers, $366,000, or about $6.30 per sq.ft. of roadway and sidewalk area. These high figures were due to the cost of importing material and labor.

Costs of Mortar Lining on Irrigation Canals

BY HERBERT D. NEWELL*

The distribution system of the Umatilla Project of the U. S. Reclamation Service is generally located in sandy soil and seepage losses have been excessive. Water was first turned into the system in the spring of 1908. In one canal having a length of 3½ miles and designed to carry a maximum of 30 sec.-ft., it took three trials of several days each to force water to the far end. The volume of flow at the head varied from 12 to 20 sec.-ft. with a fair average at the intake of 16 sec.-ft. The next year some 200 acre-ft. were used in priming this canal. In another canal three miles long, the fourth year it was operated, with 30 sec.-ft. at the intake only 20 sec.-ft. were left at the far end. In a farmer's lateral having 1.2 sec.-ft. at the head only 0.4 sec.-ft. was left in a distance of 1100 ft. In another case where water was necessarily backed up somewhat, 8 sec.-ft. were turned into a canal in order that 1 sec.-ft. might be delivered to a water user about one mile distant. In the more pervious materials, canal losses total as much as 3 ft. vertically in 24 hours, and in some cases this depth has been exceeded.

It became evident that, as the project developed, if an adequate supply of water were to reach the irrigable lands, losses in the distribution system must be greatly reduced. As an experiment, about 1000 lin.ft. of small lateral located in fill were lined during the fall of 1910. The lining was 1 in. thick, composed of 1 part cement to 4 parts sand. The section had a bottom width of 3 ft., depth 2 ft., side slopes 1½ to 1. Experiments made that autumn indicated that losses in this lined section amounted to 0.2 ft. vertically in 24 hours. The lining passed through the winter without showing injurious effects from cold weather. Authority was obtained in the summer

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TABLE I—ITEMIZED COST OF LINING CANAL M—23,577 SQ. YD.

Item	Cost	Cost per sq.yd.
Labor:		
Engineering	$ 323.00	$0.013
Foremen	495.84	0.021
Truing ditches	1,099.17	0.046
Mixing and placing mortar	1,460.31	0.062
Obtaining sand	865.39	0.037
Miscellaneous	227.89	0.010
Hauling cement	685.51	0.029
Moving camp	116.36	0.005
Excavation, teams and teamsters	2,016.26	0.086
Excavation, laborers	407.20	0.017
Building forms	14.40	0.001
Backfilling	285.83	0.012
Materials & Supplies:		
Cement	3,437.50	0.146
Lumber	50.00	0.002
Fuel	62.95	0.003
Miscellaneous supplies	39.00	0.002
General Expense*	1,483.30	0.063
Total	$13,069.91	$0.555

*General expense covers all expenditures not directly chargeable to specific items. It includes clerical and administrative charges of the project office, Supervising Engineer's office and that of the Director. It further includes legal expenditures, cost of the Transportation office at Chicago, and expert engineering.

TABLE II—CLASSIFIED COST OF LINING CANAL M—23,577 sq.yds.

Item	Cost	Cost per sq.yd.
Engineering	$323.00	$0.013
Earth Work		
Excavation, stripping sand pits, backfill, etc., 35,580 cu.yd. $2,907.63		
Truing ditch 1,211.07	4,118.70	0.175
Mixing and placing mortar	1,660.31	0.071
Materials		
Cement delivered, 1719 bbl. $4,123.01		
Sand delivered, 1020 cu.yd. $865.39	4,98.408	0.212
Fuel, Lumber and supplies	151.95	0.006
Moving camps	116.36	0.005
Miscellaneous	227.89	0.010
General Expense	1,483.30	0.063
Total	13,069.91	$0.555

Unit Costs—The tabulations show that 23,577 sq.yd. were placed at a total cost of $0.555 per sq. yd. Excluding general expense the cost was $0.491 per sq.yd.; excluding general expense and earth work it was $0.317 per sq.yd.

Expressed in cubic yards, 982 cu.yd. were placed at a total cost of $13.31 per cu.yd. Excluding general expense the cost was $11.80 per cu.yd.: excluding general expense and earth work it was $7.61 per cu. yd.

Expressed in lineal feet, 12,409 lin.ft. were lined at a total cost of $1.053 per lin.ft. Excluding general expense the cost was $0.934 per lin.ft.; excluding general expense and earth work it was $0.602 per lin.ft.

TABLE III—AVERAGE DAILY CREW AND SCALE OF WAGES ON CANALS

Excavating Ditch:			
1 Foreman	@ $4.00	$ 4.00	
4 Laborers	@ 2.40	9.60	
7 4-horse Fresno teams	@ 6.25	43.75	
1 2-horse plow team	@ 4.25	4.25	$61.60
Truing Ditch:			
1 Laborer	@ 2.60	2.60	
9 Laborers	@ 2.40	21.60	
2 2-horse scraper teams	4.25	8.50	32.70
Mixing and Placing Mortar:			
1 Foreman	@ 4.00	4.00	
1 Spreader	@ 2.60	2.60	
9 Laborers	@ 2.40	21.60	
1 Engineer on Mixer	@ 3.00	3.00	
1 Laborer running pump	2.40	2.40	33.60
Obtaining Materials:			
3 Laborers sacking sand	2.40	7.20	
4 4-horse teams hauling sand and cement	6.25	25.00	32.20
Total			$160.10

TABLE IV—COST OF LINING OTHER CANALS —9,377 SQ. YD.

Item	Cost	Cost per sq.yd.
Engineering	$ 423.77	$0.045
Earth Work:		
Excavation, truing section, etc	1,492.99	0.159
Mixing and placing mortar	1,348.57	0.144
Materials:		
Cement delivered, 685 bbl. $1,959,24		
Sand delivered, 530 c.y. 655.19	2,614.43	0.279
Fuel, lumber and supplies	93.90	0.010
Miscellaneous	259.12	0.028
General Expense	934.25	0.099
Total	$7,167.03	$0.764

Unit Costs—The tabulation shows that 9377 sq. yd. were placed at a total cost of $0.764 per sq.yd. Excluding general expense the cost was $0.665 per sq.yd.: excluding general expense and earth work it was $0.525 per sq.yd.

Expressed in cubic yards, 440 cu.yd. were placed at a total cost of $16.29 per cu.yd. Excluding general expense the cost was $14.17 per cu.yd.: excluding general expense and earth work it was $11.18 per cu. yd.

Expressed in lineal feet, 9052 lin.ft. were lined at a total cost of $0.792 per lin.ft. Excluding general expense the cost was $0.689 per lin.ft.: excluding general expense and earth work it was $0.543 per lin.ft.

of 1911 for placing mortar lining on an extensive scale, and at the close of the irrigation season the work was vigorously prosecuted. The following is a statement of the methods used, cost of the work, and results thus far obtained.

Canal M

This canal is 12,409 ft. long. The finished section is trapezoidal, having a bottom width of 4 ft., depth 4 ft., side slopes 1¼ to 1. A view of a portion of the canal is shown herewith. The lining is 1½ in. thick, with a curb at the top 4 in. wide and 3 in. thick. A new canal was built with excellent alignment.

The work was begun Sept. 18 and completed Nov. 17, eight hours constituting a day's work. Weather conditions were not favorable, sunny days and cold nights being the rule with little rain. Beginning Oct. 18 for the rest of the month minimum temperatures were below 32° every morning except two. The lowest October temperature was 16°, and ten mornings were below 25°. During November, ten mornings were below 32°, five were below 25°, one was 16°. The lining was somewhat damaged by frost, but apparently not seriously. The excavation was in sandy soil and the work was done by Fresno scrapers. The earth section was trued up by filling against a wooden templet 16 ft. long, which was moved ahead by a two-horse team. The backfilling was wet and tamped.

The mixture was 1 part cement to 4 parts sand, by volume. Sand was obtained from pits close to the work by stripping 2½ ft. The quality was rather poor; it was fairly clean but too uniform in size and too fine for the best results. Cement cost $2 per bbl. at Hermiston and was hauled three or four miles over sandy roads. A four-horse team would haul 40 to 45 sacks per load.

The mortar was mixed by a mixer of 6 cu.ft. capacity, mounted on trucks. It was spread on the finished section by trowels. Water was supplied to the mixer and to the crew trueing the ditch by a 2-hp. gasoline pump through 2-in. pipe. Water was run to the pump by gravity through the finished section.

Cost data for Canal M are shown by Tables I and II, the first table giving itemized and the second classified costs.

The wage scale on all the canals described here is shown in Table III.

Other Canals

During the fall of 1911 lining was placed in other canals where it appeared most needed. Generally a number of relatively short stretches were lined. The sections varied from a bottom width of 4 ft., depth 3½ ft. to a bottom width of 1 ft., depth 1½ ft. Side slopes were generally 1¼ to 1. The thickness of lining and proportion of mixture were similar to those in Canal M. Mortar was hand mixed; in other respects the methods employed were similar to those outlined for Canal M. In addition, nearly 3000 lin.ft. of Canal A were side lined, and for a small part of this work a mixer was used. No itemized cost is given for

A Portion of Cement-Mortar Lined Canal Umatilla Project, U.S. Reclamation Service

TABLE V—ITEMIZED COST OF LINING CANAL L—3,343 SQ. YD.

Item	Cost	Cost per sq.yd.
Labor:		
Engineering	$ 53.10	$0.016
Foremen	69.00	0.021
Truing ditches	235.00	0.070
Mixing and placing concrete	266.80	0.079
Obtaining sand	361.45	0.108
Hauling cement	50.60	0.015
Materials and Supplies:		
Cement	414.00	0.124
Misc. supplies	23.51	0.007
General Expense	162.16	0.049
Total	$1,635.62	$0.489

TABLE VI—CLASSIF IED COST OF LINING CANAL L—3,343 SQ. YD.

Item	Cost	Cost per sq.yd.
Engineering	$ 53.10	$0.016
Earth Work: Truing ditches	269.50	0.081
Mixing and placing mortar	301.30	0.090
Materials:		
Cement, delivered, 230 bbl. $464.60		
Sand, delivered, 136 cu.yd. $361.45	826.05	0.247
Miscellaneous supplies	23.51	0.007
General Expense	162.16	0.048
Total	$1,635.62	$0.489

Unit Costs—The tabulations show that 3343 sq. yd. were placed at a total cost of $0.489 per sq.yd. Excluding general expense the cost was $0.441 per sq.yd.; excluding general expense and earth work it was $0.36 per sq.yd.

Expressed in cubic yards, 139 cu.yd. were placed at a total cost of $11.74 per cu.yd. Excluding general expense the cost was $10.60 per cu.yd.; excluding general expense and earth work it was $8.66 per cu.yd.

Expressed in lineal feet, 3009 lin.ft. were lined at a total cost of $0.543 per lin.ft. Excluding general expense the cost was $0.49 per lin.ft.; excluding general expense and earth work it was $0.40 per lin.ft.

TABLE VII—ITEMIZED COST OF LINING CANAL T—7412 SQ.YD.

Item	Cost	Cost per sq.yd.
Labor:		
Engineering	$146.20	$0.019
Foremen	148.66	0.020
Truing ditches	272.46	0.036
Mixing and placing mortar	427.28	0.057
Obtaining sand	474.50	0.063
Miscellaneous	147.06	0.019
Hauling cement	283.00	0.037
Moving camp	91.64	0.012
Excavation, teams and teamsters	723.00	0.097
Excavation, laborers	131.40	0.017
Backfilling	149.20	0.020
Materials and Supplies:		
Cement	1,200.15	0.161
Lumber, etc	12.61	0.012
Fuel	28.76	0.003
Miscellaneous supplies	28.52	0.003
General Expense	369.26	0.049
Total	$4,633.70	0.625

this group of canals; but Table IV shows the cost of the work classified according to features.

Canal L

In the spring of 1912 further lining was placed. Canal L may be taken as typical of a small canal where mixing was done by hand. The finished section is trapezoidal, 2 ft. on the bottom, depth 2½ ft., side slopes 1¼ to 1. Lining is 1½ in. thick. The former alignment was generally followed, so cost for truing section was comparatively low. The mixture was similar to that used for Canal M and similar methods were generally used throughout, except hand mixing was done. Cement cost $1.80 per bbl. at Hermiston and was hauled five miles over sandy roads. A four-horse team would haul 45 sacks to a load. Sand was obtained from a pit within one-half mile of the work by stripping 2 ft.; it was clean but rather fine.

Work began in March and was completed early in April, 1912. Cold weather in March damaged the lining somewhat but not seriously. One morning the temperature was 18°, and several mornings the temperature was below 25°.

An itemized cost statement is shown in Table V. For convenience a tabulation showing cost of work grouped in features is submitted in Table VI.

TABLE VIII—CLASSIFIED COST OF LINING CANAL T—7412 SQ. YD.

Item	Cost	Unit Cost
Engineering	$ 146.20	$0.020
Earth Work: including seeding and brushing	1,350.30	0.182
Mixing and placing mortar	501.61	0.067
Materials:		
Cement delivered, 667 bbl., $1483.15		
Sand delivered, 395 c.y...474.50	1,957.65	0.264
Lumber, fuel and supplies	69.89	0.010
Moving camp	91.64	0.012
Miscellaneous	147.06	0.020
General Expense	369.26	0.050
Total	$4,633.70	0.625

Unit Costs—The tabulations show that 7412 sq. yd. were placed at a total cost of $0.625 per sq.yd. Excluding general expense the cost was $0.575 per sq.yd.; excluding general expense and earth work it was $0.38 per sq.yd.

Expressed in cubic yards, 360 cu.yd. were placed at a total cost of $12.87 per cu. yd. Excluding general expense the cost was $11.85 per cu.yd excluding general expense and earth work it was $7.82 per cu.yd.

Expressed in lineal feet, 5112 lin.ft. were placed at a total cost of $0.906 per lin.ft. Excluding general expense the cost was $0.834 per lin.ft.; excluding general expense and earth work it was $0.55 per lin.ft.

TABLE IX—ITEMIZED COST OF SIDE LINING CANAL A—3158 SQ. YD.

Item	Cost	Cost per sq.yd.
Labor:		
Engineering	$ 63.11	$0.020
Foremen	46.74	0.015
Truing section	255.69	0.081
Mixing and placing mortar	231.32	0.073
Obtaining sand	242.08	0.077
Miscellaneous	31.90	0.010
Hauling cement	164.25	0.052
Moving camp	45.00	0.014
Excavation, laborers	7.60	0.002
Materials and Supplies:		
Cement	583.65	0.185
Lumber, etc	35.48	0.011
Fuel	32.12	0.010
Miscellaneous	29.43	0.010
General Expense	258.39	0.082
Total	$2,026.76	$0.642

Canal T

This canal, 5112 ft. long, was lined in March and April, 1912. The finished section is trapezoidal, bottom width 3 ft., depth 3 ft., side slopes 1¼ to 1. The lining is 1¾ in. thick with a curb at the top 4 in. wide and 3 in. thick.

The mixture and methods employed were essentially similar to those used on Canal M. The former alignment was generally followed. A portion of the canal was in rather high fill and the location was necessarily somewhat shallow, causing a heavy expense for filling and building banks. Cement cost $1.80 per bbl. at Hermiston and was hauled six miles over sandy roads. A four-horse team would haul 45 sacks at each load. Sand was obtained from pits close to the work by stripping 2 ft. The quality was poor, it being too uniform in size, fine and dirty.

Cold weather in March injured the lining somewhat. One morning 18° was recorded and several mornings the temperature was below 25°.

An itemized cost statement is shown in Table VII and classified costs are given in Table VIII.

Canal A

During March, 1912, Canal A was partly side lined. This canal has a bottom width of 15 ft. and the designed maximum depth of water is 5 ft. The lining is 2 in. thick, slant height 10 ft., side slopes being 1¼ to 1, and is placed against the outer bank. The former alignment was followed and the bank was trued by slip teams and by hand. Water was supplied by plowing a furrow in the bottom of the canal and running the water to the work as needed.

TABLE X—CLASSIFIED COST OF SIDE LINING CANAL A—3158 SQ. YD.

Item	Cost	Cost per sq.yd.
Engineering	$ 63.11	$0.020
Earth Work: truing section and excavation	286.66	0.091
Mixing and placing mortar	254.69	0.081
Materials:		
Cement, delivered, 324 bbls. $747.90		
Sand, delivered, 192 c.y...242.08	989.98	0.313
Lumber, fuel and supplies	97.03	0.031
Moving camp	45.00	0.014
Miscellaneous	31.90	0.010
General Expense	258.39	0.082
Total	$2,026.76	$0.642

Unit Costs—The tabulations show that 3158 sq. yd. were placed at a total cost of $0.642 per sq.yd. Excluding general expense the cost was $0.56 per sq.yd.; excluding general expense and earth work it was $0.469 per sq.yd.

Expressed in cubic yards, 175 cu.yd. were placed at a total cost of $11.61 per cu.yd. Excluding general expense the cost was $10.10 per cu.yd.; excluding general expense and earth work it was $8.47 per cu.yd.

Expressed in lineal feet, 3036 lin.ft. were placed at a total cost of $0.667 per lin.ft. Excluding general expense, the cost was $0.582 per lin.ft.; excluding general expense and earth work it was $0.488 per lin.ft.

The mixture was 1 part cement to about 4 parts sand, by volumes. Cement cost $1.80 per bbl. at Hermiston and was hauled six miles over sandy roads. A four-horse team would haul 45 sacks to a load. Sand was obtained from a pit one-half mile or more distant and was hauled across a gorge 60 ft. deep; it was fairly coarse but rather dirty. Mortar was mixed by a mixer on trucks, 6 cu.ft. capacity. It was spread on the finished section by trowels.

An itemized cost statement is shown in Table IX, and for convenience a tabulation showing the cost of work grouped in features is submitted in Table X.

Effect on Seepage

Seepage losses appear to have been nearly eliminated in lined sections. A series of gagings made in 1912 on Canal M show losses in about 2.2 miles as follows:

		Sec.ft.
April 27,	Measured inflow	7.12
	Turned out from canal	7.07
	Apparent loss	0.05
May 2,	Measured inflow	23.64
	Turned out from canal	23.87
	Apparent gain	0.23
May 7,	Measured inflow	13.55
	Turned out from canal	13.54
	Apparent loss	0.01
June 7,	Measured inflow	19.16
	Turned out from canal	18.91
	Apparent gain	0.25
July 19,	Measured inflow	19.90
	Turned out from canal	19.90
	Apparent loss	0.00

The result of the series indicates that the lining placed has practically eliminated seepage losses.

Design of Harbor Works at Portland, Ore.*

By C. W. Staniford,† E. P. Goodrich‡ and W. J. Barney§

Feasibility of Developing Portland Harbor

A port should be developed as a terminal, not as an aggregation of individual piers constructed as immediate needs demand. Each should have some logical relation to the others, and to the upland immediately adjacent.

In a port already developed, especially by private interests, this is difficult. The expense is often seemingly prohibitive and leads to makeshift policies by public harbor commissions. In the long run, the larger expenditures under a logical plan are the most economical and should be insisted upon, even if it is necessary to educate public opinion.

Comparison with other Ports—Justification of this assertion is shown by a brief consideration of the great ports of northern Europe and this country. For comparison, the ports shown in Fig. 1 have been selected upon rivers or at the head of tidal navigation on estuaries; in their beginning these ports had far less natural advantages than Portland. Their original channels were narrow, tortuous rivers, from which navigable channels have been made only by extensive and costly dredging operations. These approaches must always be maintained at enormous expense, as the rivers leading to the sea deposit much silt to form obstructions.

The channel dredged from Portland to the sea, on the contrary, will always be more easily maintained, as the waters of the Willamette and Columbia deposit comparatively little sediment and their scouring tends to keep the channel clear. Abroad, the national or state government coöperates with the municipality; here, in a like manner, the federal government is joining with the Port of Portland.

That a river approach is considered no disadvantage to commercial activity in this country is made evident by Philadelphia, on the Delaware, 94 miles from the coast, and where the river is about 2000 ft. in width. Philadelphia is in the field with extensive port projects which place it in direct competition with New York, Boston and Baltimore, all practically outside harbors. New Orleans and Montreal are further striking examples.

In the face of great natural obstacles, Liverpool (population 800,000) has risen from a small village to one of the greatest ports in the world solely by following a consistent and logical policy of development. It has taken this lead at a cost of over $125,000,000.

In a still more striking manner, the town of Manchester, England (population 900,000), at a cost of $90,000,000, has created a harbor second to none in equipment and efficiency though on an artificial channel 35½ miles from its junction with the Mersey, 19 miles from the sea.

In 1908 London (population 7,500,000) took over $190,000,000 worth of private docks and warehouse improvements and is now consolidating these into an organized terminal port. The Port of London Authority, moreover, has installed at Tilbury, near the mouth of the Thames, another complete dock system, to overcome the disadvantages of the upper reaches of the Thames for larger vessels. Here the river is but 1500 ft. in width, narrowing to 900 ft. at Deptford.

Antwerp (population 300,000) is some 59 miles from the sea on the river Schelde, which has a width of 1500 ft. Its approach has been constructed at great expense through the shifting sand, demanding constant and expensive dredging. Careful navigation is required through a buoyed channel. These improvements, which rank among the foremost of the world, have cost already $45,000,000 and there is in course of construction a $60,000,000 project to turn the entire bed of the river below the present port into a series of basins with adjoining slips, forming in all some eight large piers.

Rotterdam (population 425,000), some 22 miles from the sea on the river Maas, has likewise committed itself to the expenditure of many millions in addition to $33,000,000 already spent in improvements which are the result of the port policies accepted by the people.

Hamburg (population 875,000) is another striking example. It is located on the river Elbe at 75 miles from the North Sea. Over $80,000,000 has been expended on an enormous system of docks, quays, warehouses and mechanical equipment. The channel here has a width of only 1200 ft.

Bremen (population 260,000) has created a harbor on the river Wesser where the width is only 400 ft. The approach requires 70 miles of river navigation in addition to 30 miles of channel from the outside bar on the North Sea.

Glasgow is undoubtedly the most impressive example for Portland of what can be secured by indomitable energy and large expenditures of money. Originally the river Clyde was only 15 to 18 in. deep in many places. As far down as 12 miles below the city it was fordable. Today the Clyde is one of the great navigable harbors of the world, 22 ft. deep at low tide and 33 ft. at high. Its construction is considered a triumph of engineering skill, especially as a large part of the excavation was through solid rock. Around these harbor improvements, and largely dependent upon their growth, has sprung up an industrial center with few equals in the world. So marked is the example of Glasgow that the port authorities of Montreal have stated "it was the success of the improvements on the Clyde which prompted the movement on the St. Lawrence ship canal through Montreal."

The Portland Situation—The further inland the transference between water and land carriers takes place, the greater the advantage in reduction of cost of freight handling, since under these conditions freight is carried further by water—decidedly the cheaper method. Portland has other advantages besides this inland location which render it susceptible of large harbor growth, provided advantages are taken of existing possibilities of increasing harbor facilities. It has proper and sufficient room compared with many of the other very congested but most important cities and harbors of the world. The original widths of channel in the foreign rivers noted have been greatly augmented only by digging inland extensive and elaborate basins. Portland can secure these results at a minimum cost. The question as to whether Portland is justified in assuming that it may be able to take a position on the Pacific Coast as a great harbor can therefore be answered in the affirmative.

It is not to be understood that Portland can expect to take immediately a place with the greatest harbors in the world, or be justified in present expenditures such as have been made for the harbors of the Atlantic Coast. Those harbors are all backed by hinterlands teeming with population, factories and industrial developments, whereas a great part of the Willamette and Columbia Valleys still remain to be industrially developed. On the other hand, the history of these ports and their success clearly demonstrates the great future that lies in front of Portland when the hinterland is likewise developed, since Portland is strategically placed at the funnel of this great and promising inland empire. The term funnel is correctly used, since all the waterways lead to Portland and all natural grades of railroad are down the valleys of the Willamette and Columbia.

The Willamette River is navigable during favorable stages for a distance of 171 miles, for vessels drawing not more than 2 ft., in addition to many hundreds of miles that the Columbia River and its tributaries are navigable for vessels of light draft. The total traffic handled in the year 1908 by river vessels aggregated

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*Brief abstract of portions of a report made by the authors as a Board of Consultation to the Commission of Public Docks of Portland, Ore.

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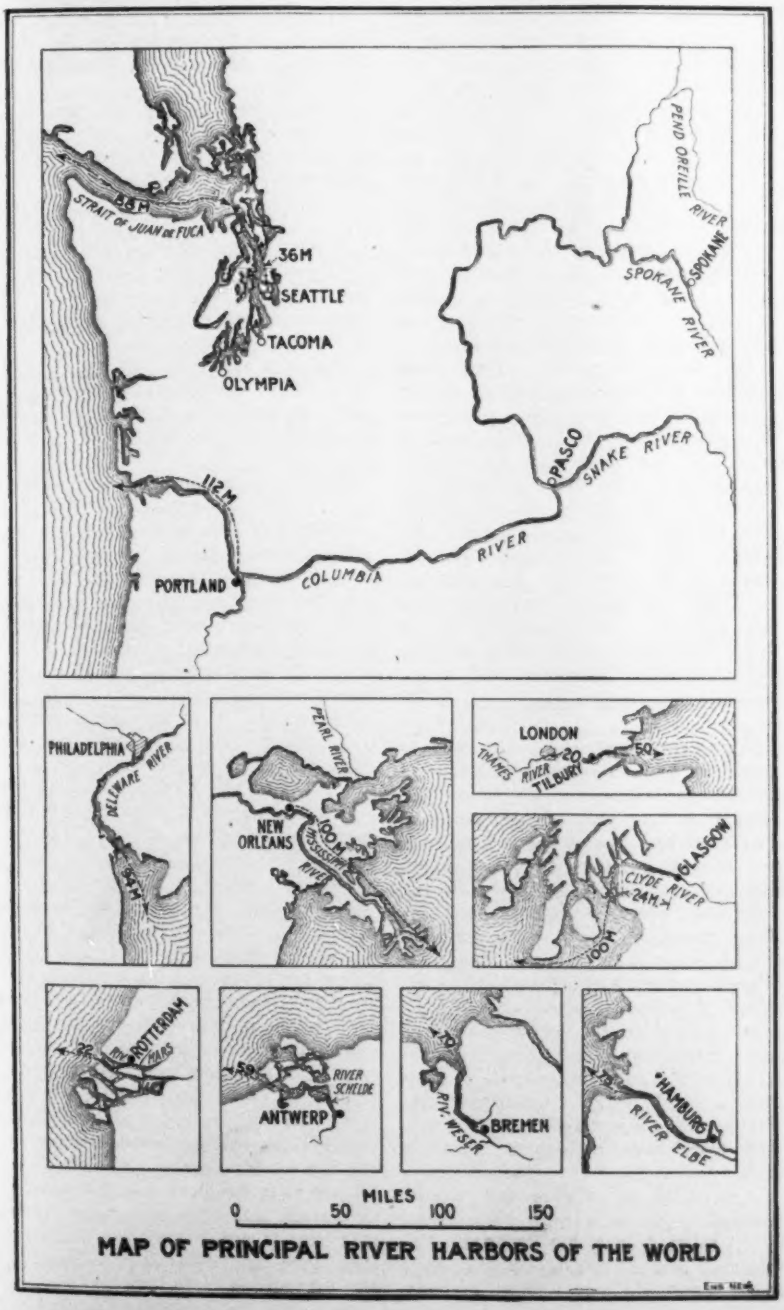
3,000,000 tons, compared with 1,686,000 tons carried by sea-going vessels. If Portland can maintain this volume of tonnage and increase it at the same rate which has been followed for the past decade she will compare favorably with the ports of Europe, with their highly developed canal and river traffic, in the ratio between inland water and seaborne commerce.

Portland suffers, against its natural advantages, the disadvantage of being subject to extreme rises in the level of the river due to freshets at certain times of the year and to backwater at others. This condition can be met with no great expense by building two-level docks for some classes of commerce, while high-level docks are built for others. These conditions can be improved upon in many instances by using power appliances for hoisting and handling.

Force of habit will maintain existing conditions against considerable efforts to alter them. Portland can be expected to maintain her existing position in the face of active competition of competitors, who are even more advantageously situated with regard to the Pacific, but not more so with regard to the hinterland. She needs simply to spend enough money to foster the natural growth of commerce which is normally to be expected and to take care to develop enough new lines of commerce to counterbalance any expected losses of special commodities like lumber and grain. Portland is situated at a point which will always be a natural center and can consequently proceed to the expenditure of large sums for port improvements, secure in the knowledge that a large return is almost certain.



MAP OF PRINCIPAL RIVER HARBORS OF THE WORLD

Planning Port Developments

A port is a clearing house for commodities. The incoming freight may arrive by water from foreign or domestic ports; it may arrive by railroads from across the continent or from nearby communities; it may come by motor- or horse-drawn truck from local merchants and manufacturers. Such activities of a clearing house make necessary easy ingress, quick transfer and easy outgo. To make the clearing process an economical one, there must be large capacity and heavy use. The sea port must be so located as to be easy of access by water, railway and highway. A proper relation must exist between the land and water areas and the means of interchange of traffic between them, and these several areas must be of such quality as to make them possible of truly economic use. The water should be of proper depth, but not so deep that easy anchorage cannot be secured. The harbor bottom must be of such material as to afford good anchorage, the approach of the ocean should be of ample width and depth and properly protected with breakwaters, buoys, etc. The land should be such that buildings can be easily erected on proper foundations. The location and tributary population should be such as to make possible a heavy tonnage so as to develop numerous lines of communication and large numbers of carriers. The population of the community and tributary territory should be large enough to supply proper labor for handling merchandise to produce materials needed in commerce and to consume such other products as to make possible approximately equal quantities of inbound and outbound cargo, Portland has these natural requirements, but the proper developments remain to be carried out.

Probable Growth—The rate of recent growth of Portland has been greater than that of any eastern city, but not much greater than that of New York from 1820 to 1860, or that of Newark, N. J., from 1830 to 1860. It is even less than that of Jersey City from 1850 to 1870. All western cities are experiencing a marked boom and care needs to be exercised in Portland to prevent the depression which often follows. The present rate of growth would result in a population of 3,000,000 in 1950, but it

is more likely that it will not exceed 1,500,000. That figure has been used in planning the port developments.

In any city of size, occupations are so varied that practically the same relative distribution is seen in all such communities and may be looked for in future places. Also, with normal growth, practically identical relations should hold with regard to commerce, transportation, manufacturing, building, financial operations, and other social and civic phenomena, as can be noted elsewhere. Thus from the provisions for handling harbor traffic in other ports, in proportion to population, we can estimate what Portland should need from period to period for its best development.

PRINCIPLES OF PLANNING—A relationship exists in an efficiently designed port between the land and water areas, between the length of water frontage and the tonnage to be handled over it, or the tonnage in proportion to the people served in the community and to those occupying the tributary territory of hinterland.

The ratio of land and water areas depends upon the speed with which vessels can approach the wharf, the rapidity of unloading and movement of cargoes from wharf sheds and whether goods are stored in warehouses adjacent to the waterfront or at once shipped to distant points. More water area is required where vessels must approach the dock slowly and must anchor for longer or shorter periods.

The speed with which cargo is removed and loaded will determine the length of port required and, therefore, the proportionate width of water area necessary to accommodate vessels approaching and anchored while waiting to discharge and load. Width of wharf shed will depend on celerity with which cargo is removed from that structure, provided always that the wharfage along the water is to be constantly used for discharge and loading of vessels, the wharf shed not being used for strictly storage purposes to any appreciable extent.

The amounts of the cargoes transhipped by rail will determine the amount of trackage required, and amount of wharf space necessary for railroad tracks, sidings and yards. Amount of cargo stored near the waterfront will determine the size of warehouses within the limits dictated by class of commodity handled, bulky produce requiring more space than metals and other heavy cargo.

Experience alone can determine the relative spaces required for the several parts of a port. Such information about the efficiently designed ports of the world has been obtained from many reports and used in fixing the limits of the work proposed.

PRESENT FAULTS OF PORTLAND HARBOR—The waterfront on both sides of the Willamette River, at Portland, has been developed from small beginnings, satisfying the needs of commerce from year to year. Still, private owners and railroads have isolated different kinds of commerce to the detriment of the port. The river itself has isolated the railroad interests. This has resulted in the production of a large amount of waterfront which lacks the intensive use to which it should be put, especially on account of the fact that the whole length so far as developed is only susceptible to quay development. This naturally has been that part of the river on both sides adjacent to the city proper and will always be limited to the quay type for waterfront purposes owing to the topography of the immediate water sides and owing to the growth of the city.

It should be the duty, therefore, of the Dock Commission similarly to arrange its own beginning in the already built-up section, to build structures that may admit of some enlargement for the same kind of trade, to endeavor to create a public sentiment whereby others may improve their properties on the same lines, and to force from this district some of the business which could be carried on equally as well in more remote places where property is not so valuable.

The Dock Commission should also plan for the future expansion of port facilities in such places and upon such lines that any beginnings which it makes upon these new acquisitions may be subject to a scientific and coördinated extension. The location selected, therefore, for any extensive municipal development should be at that point where the best railroad connections are available and where the best further connections may be effected in the future between the two railroad interests which are now divided by the Willamette River.

IMPROVEMENTS RECOMMENDED

A general comprehensive plan was submitted by the Consulting Board for the ultimate improvement of the whole harbor. It is only expedient, however, at the present time to describe developments recommended for the expenditure of the first appropriation of $2,500,000.

The first project, or Site 1, offers exceptional advantages for a public dock for the accommodation of larger ships. Its present occupancy is about equally apportioned to four companies whose business has relatively little connection with waterfront facilities. The site is of ample depth to afford a complete unit of terminal installation, including wharves and sheds, railroad sidings, warehouses and truck unloading platforms. It has the unique advantage of practically no expense for railroad connection, being served immediately by all railroads entering Portland. Immediately behind the site is a large tract of comparatively undeveloped property permitting of extension of private warehouse interests without encroaching upon residential sections.

While the first large public dock recommended is on the west side, below the city bridges, yet the urgent necessity for public-wharf facilities on the east side of the river is realized. A dock is here immediately needed for the receipt, assembling, storage and transhipment of river freight; yet the dock should accommodate large vessels. Site 2 was selected for this dock, being fairly central and accessible to both east and west sides, fronting on local standard-gage electric-railway tracks, and having chance for direct switching, at small expense, from both railway systems entering Portland. It is a primary step for the east-side public docks of a comprehensive plan.

A motor-boat landing on the west side will serve not only as a landing place for small craft, but will afford a small recreation platform.

DOCK DESIGNS

PROPER LEVEL—Because of the importance attached to the decision as to the levels at which the docks should be constructed, considerable time was spent in investigating this point.

The rises of the Columbia River and the floods of the Willamette make river-front construction at Portland unique, as compared with the large ports of this country.

From March to June the water levels in the harbor rise from 6 to 17 ft. normally and then gradually subside to the low-water stage of the river during the fall, dropping normally to a level of 3 ft., but sometimes to 1½ ft. below the mean low water mark. This variation of the water level, normally about 17 ft., is due to the back waters of the Willamette from the Columbia.

The harbor level in winter months is constantly subject to rapid and irregular rises from the winter freshets and floods of the Willamette caused by the more rapid runoff of its watershed in comparison with that of the Columbia. These quick rises have attained a maximum height of 28 ft. and usually reach levels of from 16 to 20 ft. above mean low water. These flood conditions create a construction problem different from that of the European ports where equally great rises occur in the water level, but with daily regularity, since they are caused by the rise and fall of tides.

All the available flood records were studied as to height, duration, relation to rainfall and the effect of changes in harbor lines, bridge abutment construction and dredging operations. Data were secured as to the freeboard of vessels of all classes, including river crafts, coastwise vessels and ocean-going steamers. Data were secured as to the time and cost for hoisting cargo from and into the

holds of vessels from docks built at various heights and the cost and advantages and disadvantages of the use of permanent and adjustable slips of the mechanical-conveying and permanent types, the latter when used by dock autos and hand trucks. The river slopes during all stages were studied to ascertain if it would be possible to vary the height of the upper level at different points in the harbor.

Regularity of extreme variation has justified the enormous expense of the lock system of docks found in many ports. On the other hand, with water levels so irregular as in Portland, it is more economical to have different levels in the docks. Estimates were made of the cost of construction of the single- and double-level docks with decks at various levels ranging from 12 to 32 ft. It was finally decided to recommend a uniform height of 32 ft. for the upper deck of double-level docks and for all single-level docks. The lower line of the double-level type was placed at a height of 18 ft. above mean low water.

Discussions of the various features of Dock No. 1, its equipment, railroad service and warehouse facilities, special devices, recommendations for use, inadvisability of installation, etc., will be considered as covering the features in other docks recommended.

INITIAL CONSTRUCTION—Dock No. 1 is primarily designed for coastwise and ocean vessels of the largest type entering Portland, yet provision is made for the convenient handling of freight from and to river craft whose importance is recognized as mediums at all docks for the assembling of outbound freight and for the distribution of cargoes received from ocean ships.

A reinforced-concrete platform, 100 ft. in width, located at a level of 32 ft. above mean low water, is recommended for the two docks which constitute the river fronts of Sites 1 and 2. This platform is supported upon concrete columns founded upon timber grillage resting on piles cut off several feet above mean low water. At the back of the wharf is a concrete bulkhead wall with its top at the level of the wharf and its foundation at such a level as to secure proper footing upon the natural slope of the harbor bottom. The area back of the wall is to be filled to grade and back to the adjacent upland. When compared with other types of construction, this type is found to be cheaper than any other.

Since destructive pests, like the teredo, are not found in fresh water, the piles cut at the low level will remain permanent. Above this level all the construction is concrete and also permanent. This combination system obviates the necessity of concrete subaqueous foundations which add so much to the cost of dock structures.

Column supports are placed on 20-ft. squares and connected at the grillage level by braces for lateral support. At the wharf level for the support of the deck there is a system of girders and floor beams composed of steel I-beams incased in concrete for protection against fire and rust. The deck system further stiffens the structures. Between the deck beams are self-supporting reinforced-concrete slabs forming the deck which is in turn covered with sheet asphalt. The asphalt will protect the concrete deck from traffic wear and is easily kept clean. It is the cheapest of any deck surface in use. The concrete columns and their pile-cluster foundations support the steel-shed columns along the outside base at 20-ft. intervals, while the shed columns on the inshore side are founded on the bulkhead wall.

Of the 1030 ft. front, 730 ft. is a single-level structure with its dock surface 32 ft. above mean low water. The southerly 300 ft. is a two-level dock, the upper level at 32 ft., the lower level at 18 ft. above mean low water. This high level dock, 1030 ft. in length, is provided for large steamers and yet there is berthing space for one or two river boats. The shed area on the upper level is 103,000 sq.ft. After due allowance for driveways, columns, slips, etc., ample space for temporary storage in transit of 8000 tons of freight is provided. On the lower level a floor area of 30,000 sq.ft. affords space for 2400 tons.

Cutting this dock into separate sections by fire walls is not recommended. More economic fire prevention is found in sprinkler systems, which have time and again demonstrated their effectiveness in warehouses and dock sheds. Fire walls could not be placed closer together than about 400 ft., and a fire at night would gain sufficient headway in inflammable material to consume practically one-third of the cargo on the dock. With a sprinkler system, flames are restricted at the outbreak to an area of comparatively few feet.

ADJUSTABLE SLIPS—The double-deck section of the dock is equipped with two adjustable slips on each level. Those on the lower level have a maximum drop of 10 ft. for a length of 55 ft. The maximum incline of this slip makes a gradient slightly less than 20%, or one up which a man can wheel a hand truck with a light load or up which a stevedore and helper can wheel a full load. The maximum grade is readily mounted by a dock auto-truck fully loaded. At practically every stage of the river up to 18 ft., freight may be moved over these slips, from the lower level to boat and vice versa. Full loads can be transported in every case by a dock automobile and most times also on hand trucks. Few river boats have less than 3 ft. of free board, even when loaded, and a river stage of less than 5 ft. would have to occur before the necessity would arise for gang-plank extensions of these slips to reach the freight deck of river craft. By such extensions for 10 ft., freight can readily be carried to a boat deck at the 6-ft. level. This level minus the 3-ft. free-board would mean a water level of 3 ft. A combination of 3-ft. water stage and 3-ft. free-board would be too infrequent to justify further cutting of the dock's surface to permit of a longer slip with a lower drop.

The upper slips are also 55 ft. in length with a maximum drop of 10 ft., presenting the same range of grades as the lower slips. Every stage of the river from 18 to 32 ft., is covered in the matter of handling freight to and from river craft. At the 17-ft. stage, when the use of the lower level is discontinued, a free board of 3 ft. places the boat at the elevation of 20 ft., or 2 ft. below the edge of the upper slip at its maximum drop, and readily reached by a gang-plank extension.

Access from the street to the lower level is afforded at the southern end by a ramp from Front St. on a 5% grade. For extra heavy loads an electric snatch tackle may be provided. On the west side of the dock is installed one elevator with a loading platform, 12x12 ft., and a lifting capacity of 15,000 lb. This is for the direct transfer of merchandise between the two levels. The platform is of sufficient size to accommodate two fully-loaded dock automobiles. The elevator is to have a speed of 55 ft. per minute. Therefore, allowing for delays incident to loading and unloading of dock autos, the elevator can make a round trip a minute. If freight is moving in both directions, the amount transferred is estimated at 360 tons per hr. The lack of bad effects in having the elevator pit flooded during high water has been confirmed by experts of the largest manufacturers.

FREIGHT-HANDLING EQUIPMENT—Reference has been made to dock automobiles. There are electric motor trucks of several types capable of running loaded from 4 to 6 miles per hour and carrying loads from 1 to 2 tons. They are about 3 ft. 9 in. in width and from 7 ft. to 12 ft. long. Their wheel base is sufficiently short to permit them to enter and turn in box freight cars. Their power is sufficient to negotiate grades of 20 to 30% when loaded. One charge of electricity will operate a truck for an entire day or night at a cost of but a few cents.

In practice these trucks are operated with equal efficiency forward or backward, even by unskilled labor. Their cost ranges from $1000 to $1500. A special type is recommended, combining the chassis with flat-board bodies. This type will carry freight from the ship to any place on the dock or marginal way or

warehouse platform and permit of winches hoisting the loaded body to any floor of the warehouse, while the chassis returns to the loading point for another flat-board load. Such a dock auto can enter the port of the ship, take on its load and without additional manual handling, transfer direct to the interior of freight cars on the surface tracks at the rear of the dock shed.

Careful consideration and investigation has been given other systems. Telpherage may be economically installed when (1) volume of freight is fairly constant, (2) freight is to be transferred regularly in a given direction between given points, (3) more or less regular tiering is required to heights greater than 8 ft., (4) carriage of freight is not contemplated between points only slightly distant from each other, (5) floor space is especially valuable owing to congested conditions or excessive land values, (6) amount of manual handling of freight between railroad car, truck or ship can be reduced to a few feet before goods are placed under telpher.

At a dock for steamers carrying only general cargoes, especially a public dock where regularity of berthing is less certain, there will always be a large irregularity in volume of freight received. At such a dock, as proposed for Site 1, the point from the dock between which freight is to be transferred is constantly changing, and while a ship is unloading freight is being received for its outward bound cargo which means cross streams of traffic. A large part of the carriage will be for short distances presumably in many cases directly across the docks to the railroad tracks or only half of the width of the dock to waiting trucks. To perform such short hauls with such an expensive system as overhead telpherage would be prohibitive. Your board laid out a telpherage installation for Dock 1, providing services to each of the warehouses and continuously along the front and the rear of the dock shed. The rail installation was laid out to cover the most points with a minimum amount of rail. The cost of such a system with a sufficient number of telphers to fully meet requirements when two ships were unloading is estimated conservatively at $75,000. Your board estimates that the same facilities can be rendered by dock autos for $13,000.

Careful consideration has been given to other general types of freight-handling devices. Under proper conditions for the transference of outer bound goods from warehouses to a dock front an installation of endless freight carriers might be employed. The carrier could be installed at the second floor level, running along the front of the gallery as shown on the accompanying plans, crossing the marginal way over the freight tracks at the back of the dock shed, passing across the sheds to the dock front where the merchandise could be delivered by chute into longitudinal freight carriers. From these longitudinal carriers the freight could be delivered by chutes to any point on the dock front, there to be picked up by slings and placed in the hatches of a ship. Each warehouse would be equipped with two vertical carriers, each placed in a well at the locations indicated. This installation would be solely for outbound cargo and could be made greatly to facilitate both the loading of the ship and the unloading of inward cargo.

The advantage would be only in a definite method of operation. For instance, if a company should lease or occupy the central chamber of the third floor of warehouse No. 1 with a ship calling twice a month, all miscellaneous merchandise of this line would be assembled in the company's warehouse chamber instead of being assembled on the dock front. The ship would be placed at the end of Dock 1 (Fig. 3), directly by the freight carrier from Warehouse No. 1. While the cargo of the ship was being unloaded and distributed, the outbound cargo would be delivered to the freight carrier overhead as rapidly as room was made for its receipt, and in no wise conflicting with the unloading.

It would cost about $15,000 to equip a warehouse for delivery at any point along 350 ft. of dock front. The maximum capacity of such an installation is about 100 tons per hr. and freight would be handled at a cost of about 2c. per ton from the time of loading on to the vertical conveyors to the delivery at the dock.

While such a system is not known to be in actual use on any dock or pier, its practicability is unquestioned because of similar installations in factories and general merchandise houses. As the economic success of this installation depends very largely upon the proper regulation of traffic, its initial installation is recommended in only one warehouse, for example, No. 1. Such a warehouse then becomes but an assembling station for outgoing miscellaneous cargo. If the business habits and customs at Portland conform readily to this new system and there is sufficient demand for the assembling of outward cargoes in advance of the arrival of the ship, then the system can be extended to the other warehouses as needed.

It is seen, from the plans, that the 730 ft. of high level dock is provided with two mechanical slips or freight conveyors. These have a maximum drop of 22 ft. with a length of 65 ft. These are spaced sufficiently apart so that the northerly one may serve the steamer and the southerly one perform a like service for another steamer. These plans render the high level dock available for the delivery and receipt of freight from river crafts and vessels of low free-board.

DOCK CRANES—The installation of dock cranes such as are seen in the ports of northern Europe is not recommended. The custom of American ports almost universally requires the loading and unloading of ships by the winches on vessels or by dock winches. The primary reason for the growth of this custom on the Atlantic seaports (the same presumably holding good for the Pacific Coast) is that practically all trans-atlantic freight is carried in foreign bottoms and crews are shipped from foreign ports for the round trip. Therefore, the labor of this crew is available while the ship is loading or unloading in the American port, whereas upon their return to the home port the ship's crew is immediately signed off, dock labor in these ports being so much cheaper. Docks in foreign ports are frequently operated by the port authorities themselves and almost always are under regulation of the port authorities, so that the various great ports in northern Europe are gradually installing tremendous equipments of cranes and hoisting apparatus.

A further difference of port conditions, not usually considered, is the marked difference in size and type of freight car used in northern Europe and in America. The European car is only some 20 ft. in length, with a capacity of from 12 to 15 tons and usually has an open top. The freight is lifted from the hatch of the ship by one of the dock cranes and deposited directly into these open "wagons." American cars are some 40 ft. in length, with a capacity running up to 50 tons, and are usually of the side-door type, requiring such clearances that a traveling crane on the dock would have to be so elevated as to be unstable, except at large cost. Moreover, direct transference by such cranes from a ship to the cars would be practically impossible under our customs requirements.

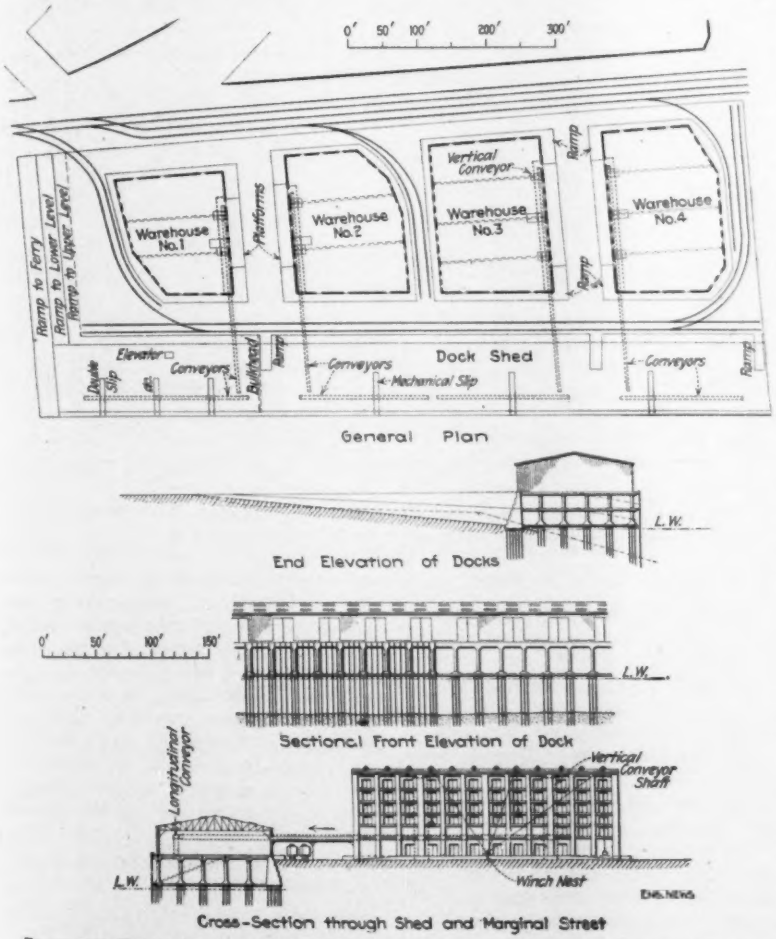
The force of port customs and conditions is clearly shown by the attitude of the Hamburg-American Line in respect to its two great trans-atlantic terminals. At Hamburg the docks of this company are equipped with numerous traveling cranes electrically operated. When new docks were to be installed at Hoboken, it was naturally assumed that a similar installation would be installed at this end. The Hamburg-American officials refused to permit the installation of dock cranes on the ground that ship and dock winches were more economical.

RAILROAD FACILITIES—Two loading tracks have been provided at the rear of the dock, the outer track in a measure serves also as a switching track so that cars may be drilled out from different points along the rear of the dock sheds. Experience at other great ports of the

world has conclusively shown that where there are large direct, lateral movements of freight between ships and railroad cars, two lines of track are required to meet full demand. The tracks here are connected at the southerly end to the main tracks on front streets. This service at present would be by a switch from street tracks of the Northern Pacific Terminal Co. Since this siding is within the yard limits of the company, it would be properly classified as an industrial siding, so that carload freight to this dock from both the big systems entering Portland for first delivery would not be subject to an extra switching charge.

ference of freight between ships and cars by dock autos, such autos are most effective where free passage is provided for rapid movement. In a shed of this length, a team driveway of at least 20 ft. in length must be reserved. To reserve further space for the passage of dock autos would decidedly reduce the available floor area under the shed. Therefore, the platform is made continuous in 300- or 400-ft. lengths as a passageway for the autos.

At the rear of the two service tracks, a marginal way 30 ft. in width, is provided. When this installation is completed the movement of team traffic



PLAN AND ELEVATIONS OF TYPICAL PROPOSED DOCK STRUCTURES, PORTLAND, ORE.

Between the standing tracks and dock sheds is provided an unloading platform 12 ft. wide. This slightly increases the hand-truck haul of freight across the docks from ships, but it is provided for two reasons: (1) Either such a platform must be provided or continuous doors must be installed in the rear wall of the dock shed to avoid the necessity of constant care in the spotting of freight cars so that doors of cars and doors of the sheds may coincide; (2) in the trans-

should not be, however, from the southerly entrance northward along this marginal way to the team entrance nearest the section of the dock to be reached. Rather, north and south traffic should be confined to front streets, teams entering directly by the east and west driveway leading to the team entrance on the dock nearest the point of destination. This marginal way is primarily designed as a place for the direct unloading between teams and the eastern chambers of the four warehouses, hence the width is only 30 ft.

WAREHOUSES—Four warehouses are shown, each six stories high. The eastern chambers will receive their freight from trucks and deliver thereto on the platform provided along the marginal way. The east and west driveways between each of these warehouses are not only for the entrance and egress of teams, but are also of sufficient width for the direct delivery of team freight on platforms provided between these driveways and the walls of the warehouses. These east and west platforms are 20 ft. wide and at their easterly end is a ramp leading to the marginal way. This ramp is designed to permit the passage of dock autos to the platform, for the delivery of freight either directly in the ground chambers, or beneath the winches of the respective upper chambers for which freight is destined. In the other east and west alleyways are provided direct sidings for the transference of freight between the cars and warehouses. The platforms between these tracks and warehouses are only 10 ft. in width, as it is not intended that dock autos shall operate thereon. It will be noted that the track service to the warehouse is entirely independent of the track service to the dock, so there will be no interference in the movement of these classes of freight.

The warehouses are of the usual reinforced-concrete type. On the northerly side of warehouse No. 1 is an elevator and freight-carrier gallery, already described, and two recesses for cross-over platforms for inter-delivery between separate chambers. At the back of these platforms are the stairways and the vertical carrier installations. In the smaller warehouses 1 and 2, one of these stairway wells is designed of sufficient size to permit the installation also of a freight elevator. These outside wells and galleries are installed in order to comply with the requirements of insurance companies and to secure their lowest rates.

Each chamber in these warehouses is provided with outward opening fireproof doors every 15 ft. Over each line of doors is provided tackle for hoisting by winch—the quickest, simplest and most economical means of transferring freight to the different levels of a warehouse. All of these winches are nested at one point.

[The Commission of Public Docks of Portland is made up as follows: F. W. Mulkey (chairman), Geo. M. Cornwall, Dan Kellaher, C. B. Moores, Ben Selling. The engineer of the Commission is G. B. Hegardt. Plans and specifications for the reinforced-concrete docks and steel sheds of the initial project are being prepared by C. W. Staniford, consulting engineer, of New York City.—Ed.]

Making a Highway in Two Days

By Samuel H. Lea*

General Statement

An interesting experiment in rapid road building was undertaken in Codington County, South Dakota, on June 25 and 26, 1912, when public effort was concentrated on the construction of 24 miles of trunk highway in that county.

The proposition comprised the construction of the Codington County subdivision of the Meridian Road, a proposed continuous highway to extend from Winnipeg, Canada, to the Gulf of Mexico. A reconnaissance for the South Dakota division of this road was made by the writer in October, 1911 (see Eng. News, Jan. 25, 1912).

The Codington County Subdivision follows practically an air line from north to south across the county, passing through the enterprising little city of Watertown. The work to be done was to improve existing section-line roads to conform to the requirements of the proposed trunk road. It was not expected to do more at first than to make a good earth road, which could be later improved and made a hard surfaced highway. To this end certain standards were established relating to grades, cross-sections of roadway and drainage. The work was to be done as nearly in conformity with these standards as local conditions would permit.

Plan of Action

The general plan adopted for performing the work was proposed by Mr. W. H. Stokes, a prominent business man of Watertown, who has taken an active interest in the Meridian Road since its inception. Under this plan the road was to be worked in units one mile in length; these to be numbered from 1 to 24, beginning at the north county line and extending southward through the county. Each unit to be under the direct supervision of a committee of five men; the chairman was designated captain of a mile. The committees were expected to canvas the territory adjacent laterally to their respective miles and secure coöperation from farmers and township authorities in the way of labor, machinery and tools.

It was understood that there would be a reserve force of labor and teams, furnished locally, in Watertown. This reserve was to be drawn upon in case of emergency as, for example, where promised aid on some of the miles did not materialize.

The Board of County Commissioners and the several township boards were requested to furnish tools and grading machinery. They were also asked to build such bridges and culverts as were needed to fill the drainage requirements of the road.

The machinery dealers in Watertown were asked to furnish traction engines, rollers and road graders, also such other machinery as they might have available for use in road building. Merchants were asked to contribute food for the workers, and a general call was made for volunteers in Watertown and along the road to turn out and work on the two days designated. The ladies of Watertown were requested to prepare and serve lunches for the workers on the various miles.

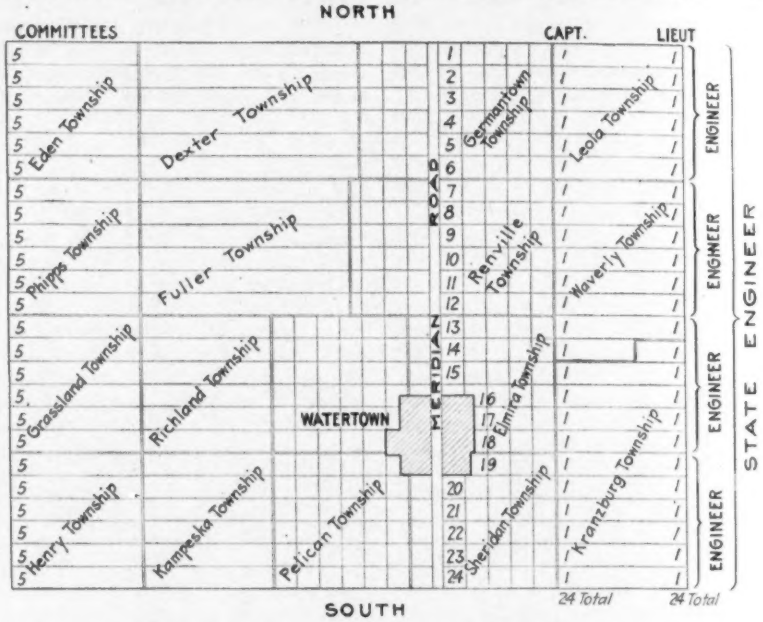


Fig. 1. Organization Plan for Constructing Meridian Road through Codington County, S. D., in Two Days

Arrangement of Work

As finally worked out, the plan of operations was made to comprise the following details:

(1) The road was divided into 24 working units; each unit, one mile in length, was worked under a captain.

(2) There were four divisions, each division comprising six miles of road. An engineer was assigned to supervise each division.

(3) The State Engineer supervised the construction work, and the general committee looked after labor supplies.

This arrangement is shown graphically in Fig. 1.

The division engineers were mounted on horseback for convenient travel over their respective divisions during construction. The state engineer traveled in an automobile, keeping in touch with the division engineers and noting local requirements of men, machinery and tools on the several miles. The committee operated from headquarters in Watertown.

Reconnaissance and Surveys

As previously stated, a reconnaissance of the route was made by the state engineer in October, 1911; the notes taken at that time formed the basis of subsequent operations. After the construction project had been decided upon and more definite data were needed, further examination of the route was made by the state engineer, assisted by F. A. Dragoun, county engineer, who recorded the notes. These comprised full information concerning needs for new bridges and culverts, also repairs to existing structures. General information concerning local improvements needed in the way of widening embankments, filling bridge approaches, reducing grades and opening side ditches, was furnished in the notes. An instrumental survey of the 24 miles of road was then made by County Engineer Dragoun and City Engineer Schreiber, of Watertown; they also made a profile of the road and an estimate of the work to be done. A set of instructions was prepared for the use of each captain in charge of a mile of the work. These instructions were issued in the following form:

General Instructions to Captains Conducting the Construction of the Meridian Road in Codington County, South Dakota

Limited time has made it necessary to omit many details. The attached estimates of labor necessary are very rough, but give some idea of the work needed to construct the road.

What details have been omitted will be left to the captains and the division engineers in local charge who will consult with the State Engineer from time to time as the work progresses.

STAKES—Stakes will be set on the center line of the road, and also on the shoulder of the crown of the road, that is, 9 ft. on either side of the centerstake. Such a set of stakes will be found every 200 ft.

*State Engineer of South Dakota, Pierre, S. D.

The center stake will be of good size, such as 2x2 in., 1x4 in., or 1x2 in., in all cases a sound stake, heavier than a common lath. These will be driven down to about the level of the ground and the cut or fill as indicated by the side stakes will be measured above or below the top of this hub or center stake.

Where considerable cutting or filling is to be done the Engineer in charge will explain any extra stake that may be set.

PLOUGHING—Before any ploughing or breaking is done it might be well for the captain of each mile to detail some of his helpers to set stakes 10 feet beyond the shoulder stakes, that is, 19 feet on either side of the center stake. In so doing a path 10 feet wide is established on either side of the crown and this 10 foot path is the space to be ploughed and shaped into side ditches and the excavation from this space will be used in building up the crown. This path is now ready for working. The sod from the same will be ploughed up and it is recommended that the sod be deposited beyond the outer line of the ditches.

The subsoil is next loosened up in these side ditches by ploughing. This subsoil is then worked gradually to the crown by road graders. The side ditches must be dug as deep as indicated on the blue print and conform to the cross-section so far as it is practicable.

CROWN—(a) Disking. Having deposited the loose subsoil material from the side ditches upon the crown, it will now be necessary if the lumps or chunks of dirt are large, to disk the surface and thoroughly pulverize the excavated material.

(b) Dragging. The surface of the crown will now be dragged by tooth drags to further pulverize and shape the crown.

(c) King Dragging. The surface is now ready for "sand papering" or smoothing and this will be done with the "split log" or King Drag. This insures a smooth surface and fills small depressions that may have been left in the process of building up the crown.

GRAVE—Gravel will now be deposited along the crown from wagons and the King Drag will again be used to distribute the gravel evenly and for final "sand papering" or smoothing.

N. B—Do not disturb the solid foundation beneath the crown, that is, 9 ft. on either side of the center stakes.

In depositing dirt or gravel for building up the crown, place same where needed and thus avoid moving excavated material more than once.

NOTE—Due to the fact that so many of the side stakes have been destroyed by vehicles driving over them, and also because of limited time, the cuts and fills were not marked upon the stakes which were set 9 ft., on either side of the center stake.

The sub-engineer in charge of the 6-mile section, in which your work is conducted, will aid the captains in determining the cuts and fills from his profiles.

Most of the existing grades are such that much cutting and filling is not required and good judgment will aid you in determining where a cut or fill is necessary.

Read the detailed instructions pertaining to your mile; also, the general instructions carefully.

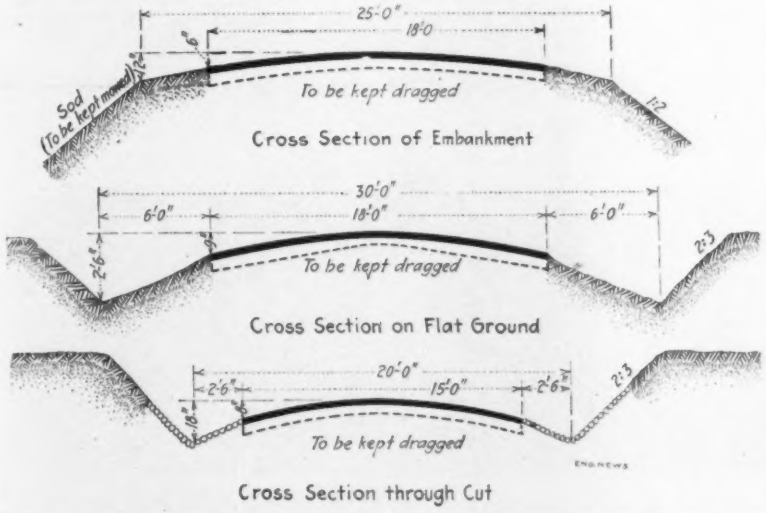


FIG. 2. THREE FORMS OF CROSS-SECTION, MERIDIAN ROAD, CODINGTON COUNTY, S. D.

Follow the center line stakes so far as possible unless necessary to deviate because of bridges.

The banner mile will be the straightest.

MILE NO. 1—This mile generally in good condition. Raise present grades about 5 or 6 in.

MILE NO. 2—This mile generally in good condition. Raise present grades about 5 or 6 in.

MILE NO. 3—This mile generally in good condition. Raise present grades about 5 or 6 in.

MILE NO. 4—Some excavation necessary in this mile as indicated on the profile. Unless otherwise indicated raise the present grades about 5 or 6 in.

MILE NO. 5—This mile generally in good condition. Raise present grades about 5 or 6 in.

MILE NO. 6—This mile generally in good condition. Raise present grade about 5 or 6 in.

MILE NO. 7—Some excavation is necessary in this mile in filling the approaches to the bridge at the north end of the mile.

Unless otherwise indicated raise present grades about 5 or 6 in.

Gravel for this mile can be obtained from pits about one half mile west.

MILE NO. 8—This mile generally in good condition and the existing grades are good. Raise present grades about 5 or 6 in.

MILE NO. 9—This mile generally in good condition and the existing grades are good. Raise present grades about 5 or 6 in.

MILE NO. 10—In this mile considerable work is necessary in grading up the fills between the three bridges and the south half of the mile. The bridges are off line and the approaches to the same should be swung from the true line toward the center of the bridges.

The grades here should be raised so as to be straight from one bridge floor to the other.

In going around the old creek follow the line closely as this part of the road is only 2 rods (33 ft.) wide.

Plenty of gravel in this mile.

Unless otherwise indicated raise the present grade 5 or 6 in.

MILE NO. 11—In this mile the old gravel pits gouge the road from either side and these places should be remedied by filling. Raise present grade about 5 or 6 in. Gravel pits in this mile.

MILE NO. 12—Considerable work is necessary on this mile in filling over the low places and widening the same. Dirt for this purpose can be obtained from the sides and by cutting the knolls as shown by the profile.

The present road is very much out of line.

The gravel pits are too near the center of the road and some heavy filling will be necessary where the line passes through the edge of the gravel pit.

Unless otherwise indicated raise the present grade about 5 or 6 in.

Gravel pits in this mile.

MILE NO. 13—Some excavation to be done in this mile in widening and raising the approaches to the Great Northern R'y. tracks.

Unless otherwise indicated raise the present grade about 9 or 10 in.

MILE NO. 14—This mile generally in good condition. Raise the present grade about 9 or 10 in.

MILE NO. 15—Some excavation necessary in this mile to be done on the hill at the north end.

Unless otherwise indicated raise the present grade about 5 or 6 in.

MILE NO. 16—This mile generally in good condition. Raise existing grades about 5 or 6 in

MILE NO. 17—About one-half of this mile lies in the residence district of Watertown and can be worked up with the general force.

The north half needs some excavation on the hill at the north end.

The south half of this mile was not staked as the line of the streets will be sufficient guide for the line.

MILE NO. 18—This mile lies largely in town and the general force can well shape this part of the road.

It is recommended that where the street crosses railroad tracks, the same be put into presentable condition by cleaning

FIG. 3. CARPENTER HILL, ON MILE 20 OF MERIDIAN ROAD

away the debris, etc. The dips in the road at the tracks and elsewhere should be filled to give good drainage.

MILE NO. 19—Some excavation is necessary on this mile, as indicated on the profile.

The old grades are considerably off line and should be straightened if possible.

The fills approaching the Sioux River bridge should be widened and it will be necessary to deviate from the true line of road to approach this bridge.

Unless otherwise indicated raise the existing grade about 5 or 6 in.

MILE NO. 20—Considerable work to be done on this mile on Carpenter Hill as indicated on the profile.

The fill to the north of Carpenter Hill should be widened.

The yardage as shown on the profile is 1471 yd. and this is below the present grade of the now traveled road. There will be between 20 and 33% additional yardage in widening the old fill and trimming down the banks. The center line is considerably east of the present cut and the captain of this mile will be personally consulted regarding the advisability of straightening the cut.

MILE NO. 21—This mile generally in good condition. Raise the present grades about 5 or 6 in.

MILE NO. 22—In this mile some excavation is necessary as indicated on the profile, that is, the fill over both culverts should be raised and the dirt obtained from the hill at the south in each case.

Unless otherwise indicated raise present grades about 5 or 6 in.

MILE NO. 23—At Stations 72, 73 and 74 the small fill over draw needs widening. If possible, pull this dirt from the hill at the south; otherwise borrow it from the sides along the right of way

At Stations 98 and 99 small fill needs widening.

Unless otherwise indicated raise present grades about 5 or 6 in.

MILE NO. 24—At Stations 23, 24, 25 and 26 the small fill needs widening. Dirt for this purpose can be borrowed from the hill at the north or from the right-of-way along the side of the road.

At Stations 37 and 38 the fill on approach to the bridge should be widened. Borrow this from the sides along the right-of-way.

Unless otherwise indicated, raise the present grades about 5 or 6 in.

Standard Cross-sections

A standard plan showing cross-sections for the finished roadway was prepared in the state engineer's office; these cross-sections were made to conform closely to those used for the Meridian Road in other states along the route. Three general forms are used, as follows: for flat or prairie sections, a width of 30 ft. between centers of side ditches, with a travelway in the center 18 ft. wide; the crown to be about 24 to 30 in. above bottom of side ditches. For embankments a width of 25 ft. between shoulders, with a travelway 18 ft. wide; side slopes from shoulders to bottom of fill to be 2 on 1. Through cuts the width between centers of side ditches to be 20 ft. and the travelway 15 ft. wide. The rise from side of travelway to crown to be 1 in. to the foot; this form of roadway is suitable for soil conditions generally in the country. Fig. 2 shows the three forms of cross-sections.

Construction Work

After the 24 committees had been organized a general meeting was held and the selection of the various miles was decided by lot. Watertown is on Miles 17-18, and these miles, comprising principally city streets, were considered more desirable than those at some distance from town. A considerable portion of the route was rather light work, but some stretches involved considerable grading to make them conform to the requirements. This was especially true of Carpenter Hill on Mile 20. The work there was too heavy to allow of completion in the short time allotted, so a temporary grade was adopted, with the understanding that it would be reduced later on. Fig. 3 shows where some excavation had been made at summit and the material used for making fill on lower ground.

After the allotment of the several miles, the committees got busy and prepared to do their work to the best advantage. On some miles the captains were machinery dealers, and in such cases they used on the work the make of traction engines sold by them. In some instances the forces on adjacent miles would combine and work them together. One enterprising chairman, captain of Mile 13, moved his forces out a day in advance and established a camp for the accommodation of his men.

Methods of Work

The work being entirely voluntary, there was no attempt made to enforce a rigid adherence to established standards. Since only two days were available as working time, there was no opportunity for breaking in green men or for developing improved methods. It was plainly a case of doing the best that could be done under the circumstances. The report furnished by the engineers was intended to serve as a guide in designating the amount of work to be done and the number of men, teams and machinery needed. In addition, stakes were set for the guidance of the workers, and the division engineers patrolled their respective divisions giving advice and information where needed.

The individual methods employed on the work were almost as many as the miles worked. For the most part the captains followed out the cross-section plans and tried to conform as closely as practicable to the cut or fill marked on side stakes. In some cases, however, the captain or foreman had ideas of his own and did his work accordingly. On two widely separated miles the road was worked the full width of right-of-way, a space of 66 ft. When spoken to about the matter by the engineer, the reply of the foreman was that plenty of room was needed for snow drifts. As the roadway was in prairie section, with practically no cut or fill, the need of precaution against snow drifts was not apparent.

The Actual Work

On June 25, 1912, business was practically suspended in Watertown and an early start was made for the Meridian Road. Owners of automobiles transported workers to their respective miles, traction engines made their way out to the work, and teams and wagons were soon on the job. The men in charge of the different miles had taken from the force of volunteers such help as they desired, and bankers, professional and business men who had not done a day's work of physical labor for years, worked enthusiastically with pick and shovel. In Fig. 4 is shown a characteristic scene on the road. The gas tractor in the background is attached to a road grader. This combination worked the material from side ditches to roadway. The shovelers trimmed up the roadway and threw out the tufts of grass, weeds and vegetable matter. Afterward the traction engine went over the roadway and packed the loose material.

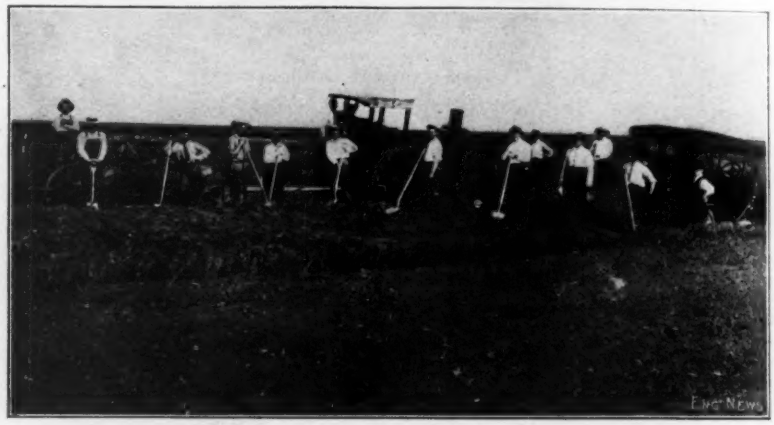


Fig. 4. Business Men of Watertown, S. D. Working on Meridian Road North of Town

In order to determine what the actual working force comprised in the way of men, teams and machinery, notes were taken by the state engineer on an inspection trip the first day, June 25. From actual count the following force was found at work: One hundred and fourteen teams of two horses each, 243 laborers, in addition to teamsters and machinery tenders. Of tools and machinery there were 10 power tractors, 14 road graders, 36 scrapers, 12 plows, three harrows and 21 wagons.

Character of Work

The work done comprised the improvement of ordinary dirt roads to make them conform to the standard adopted for the Meridian Road. For a large portion of the way there was need of but little earth movement outside of cutting the side ditches and using the material for forming the roadway. Other places required some cutting and filling and considerable material was handled for such purposes, especially at approaches to bridges. The only cut of any importance to be considered was that on Mile 20, at the summit of Carpenter Hill. Some improvement was made there but the available force was too small for doing as much work as desired.

Fig. 5. Hauling Gravel for Meridian Road, Watertown, S. D.

On the miles where traction engines were used, there was opportunity to roll and compact the material deposited in the roadway; in such cases the machines were used as rollers and did effective work.

Other miles were left in the natural state, with the expectation of using road drags later on.

On some stretches the side ditches were overgrown with weeds, and the road machines brought these into the roadway along with the excavated material. In some cases the weeds and grass were scraped off and dumped outside of ditch lines, but generally these were shoveled or pitchforked out by hand after the material was deposited in roadway.

An effort was made to place a thin coating of gravel over the entire roadway; this was done as far as practicable. At several points there are natural deposits of gravel close to the road; these were utilized for local supply as much as time and force available would permit. At Lake Kampeska, a few miles from Watertown, on the M. & St. L. Ry., is a large sand and gravel deposit worked by the Kampeska Materials Co. This company contributed for the work 30 gondola cars of gravel, which was hauled to town free of charge by the railroad company. The railroads entering Watertown furnished 20 laborers to shovel the gravel off the cars into wagons. This gravel was used on the road inside of town; it was hauled and distributed locally in trains of dump wagons attached to traction engines. A view of a gravel train is shown in Fig. 5. Several miles of the road were graveled to a depth of from 1 to 2 in. This coating is not expected to be of much permanent value, but it will serve as a beginning for subsequent improvement.

Local Conditions

On the first day weather conditions were not favorable for work, the temperature being 90° Fahrenheit at 1 p.m. On account of the extreme heat some of the crews laid off during the afternoon and worked in the evening and to 11 p.m. On one mile the work was continued through the night. The second day was better; the temperature was 20° cooler, and work was carried on to good advantage.

The heavy work and the heat on the first day combined to check the enthusiasm of the town men, a number of whom then engaged in manual labor for the first time in months or even years. Some of them who were a little overzealous were overcome by the heat, and it was necessary to bring them to town in automobiles. On the second day the work was carried on with but little friction or loss of time, the first day's work having furnished valuable experience in organization.

Conclusions

Considering the fact that much of the labor was raw and inexperienced and that the entire working force was not large, the work done was fully up to expectations. As a moral example of what can be accomplished by united effort exerted in a willing spirit, the result may be considered valuable. The example furnished will have a good effect on other communities in the state and elsewhere in giving the good roads movement a boost and encouraging emulation to efforts of a like nature.

One point brought out clearly, is the value of modern machinery for road building. The work accomplished by less than 250 men with the help of teams and machinery could not have been done by 1000 men without machinery.

The value of the power tractor as a factor in road construction was practically demonstrated on Miles 9 and 10 where there were two road machines at work; one of these was handled by team and one by a power tractor. The extreme heat and dust required the drivers to favor their teams with frequent rest periods, while the 20-hp. gas tractor kept up a steady speed of 2½ miles per hour until 9 p.m.

After the conclusion of the two-day period, Chairman W. H. Stokes of the Meridian Road Committee made a careful inspection of the 24 miles and reported that all of the work was completed satisfactorily with the exception of Miles 12 and 15. These two miles were not handled as well as the others, and they were not up to the standard; they will be finished later.

An encouraging feature of the work is a feeling of good fellowship between the city and the country resulting from the two days' association. Many farmers with their teams participated in the work and they have derived therefrom a feeling of enthusiasm and friendship toward the good roads movement that will undoubtedly have beneficial results.

The Size of Stone Ballast recommended by the Roadmasters and Maintenance of Way Association at its recent annual meeting at Buffalo was from ½ in to 2 in. A committee report had recommended a range of 1½ in. to 2½ in. (except that one member of the committee favored ½ in. to 1¾ in.), but the discussion developed such a general objection to the large sizes that the meeting voted to change the recommendation, giving a smaller maximum size and a very much smaller minimum size. The original report was published in our issue of Sept. 12.

Protection of Levees During Floods

By Arthur Hider*

The following article describes the work of protecting the levees along one section of the Mississippi River during the extensive floods of the past season. It does not deal with the reconstruction of levees when burst by floods or with the closure of crevasses in the levees to check the flow and thus limit the extent of the damage and inundation. That is another story.

*Principal Assistant Engineer, Third District, Mississippi River Commisson, Greenville, Miss.

The levees along both banks of the Mississippi River from Cairo (Ill.) to the Gulf are necessarily built on foundations formed by alluvial deposits from annual overflows and vary greatly in composition. It will be understood that the river itself is located, as it were, on a backbone, the main banks being higher than the land on each side. A short distance from the river the slope of the land falls away gradually from the river at the rate of about a foot to the mile. The gradual raising of the banks contiguous to the river is due to deposits from the annual overflows, the heavier material settling nearest to the bank of the river; the result is that after repeated overflows high banks form next to the river, with a gentle slope away from the stream.

The deposits brought down by each successive flood consist principally of fine and coarse sand, loam, clay, silt and gravel. The coarsest of these materials is deposited at the heads of the sand bars formed in the channel of the stream. These sand bars are continually in the process of formation and destruction by the action of the river, due to change in direction and force of current at different stages. The finer materials brought down by the floods are deposited on the lower ends of the sand bars, in the slackened current, and below points on the convex side of the river. Much of this finer material is silt, which has a small specific gravity.

The location of the river bed is under constant change, due to caving banks which continue until deep concave bends are formed, leaving a narrow neck between them. In time, cutoffs are formed across these narrow necks. This has caused the main channel of the river to shift backwards and forwards, leaving in each former bend an abandoned lake in the form of a crescent. Before the levees were constructed these lakes were gradually filled by the deposits from the annual overflows, principally with the finer material.

The result of these changes that have been going on for ages is that the material underlying the top soil of which the levees are constructed differs materially. In one locality it may be silt, which when hard and dry is given the popular name of "buck shot," as it breaks in small pieces resembling shot. In another place perhaps only a short distance away, the material may be sand (fine or coarse), or sandy loam. This material brought down by the river is deposited in uneven layers, in some places the stratum is only a foot or two in thickness, and at other localities the layer may be several feet in depth of one class of material followed with a layer of another kind.

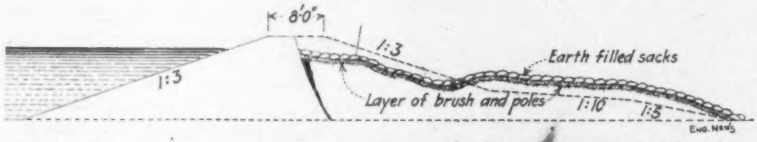


FIG. 1. STANDARD SECTION OF LEVEES, MISSISSIPPI RIVER COMMISSION; SHOWING FORM OF SLOUGHING OF REAR SLOPE WHEN SATURATED

(The dotted lines show normal section. The layers of brush and sacks of earth are to hold the weakened bank.)

LEVEE CONSTRUCTION

It will be evident that a great deal of the available material is not well suited for dikes or for levees constructed to hold water. But the use of a better material is prohibitory on account of expense, due to the long haul that would often be necessary to obtain the most suitable material, so that the material in the immediate vicinity must be used. The only resort for safety is to increase the section of the levees above what would be needed if better material was available. The standard section adopted by the Mississippi River Commission for levees is shown in Fig. 1; this has 8 ft. crown, slopes 1 on 3, with a banquette on the land side 20 ft. wide, with a slope of 1 on 10 and 1 on 5. It has been found that a levee 8 ft. wide on top with side slopes 1 on 3 built of loam or buckshot or other good material is safe and will hold out the water during high water. A flood seldom remains against the levee for more than 60 days.

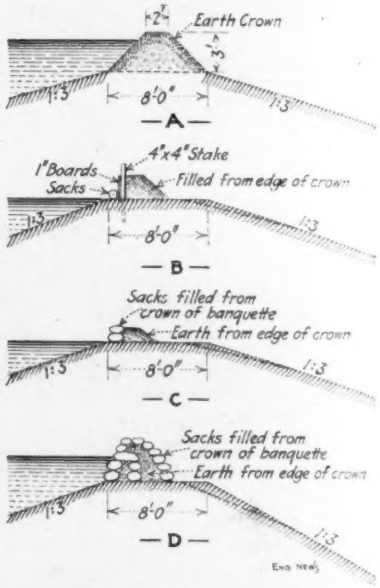


FIG. 2. METHODS OF RAISING LEVEES TO PREVENT THEM FROM BEING OVERTOPPED BY FLOOD

After the levees have been subjected to stress from a long period of high water they become saturated in many places. Then the material, on account of its porosity, becomes spongy and has little

FIG. 3. LEVEE RAISED WITH SACKS OF EARTH TO HOLD BACK FLOOD WATER

stability. Sloughing often takes place near the bottom of the back slope and occasionally extends to take in a portion of the crown of the levee.

The original levees built prior to 1882, before the U. S. Government undertook the construction of levees to aid the local levee boards, were constructed without special care in preparing the foundations by removal of stumps, roots, and logs from the base, or excavating exploring trenches or "muck ditches." The foundations of many of the old levees, which

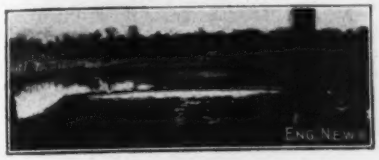


FIG. 4. A LARGE SAND BOIL ENCIRCLED BY A WALL OF SACKS OF EARTH

have been adopted as the controlling levee line, are defective. These levees have been increased both in height and section by enlargement since their original construction (with their defective foundations); and this, in many cases, is the cause of leaks and "sand boils" near the base of the levee, which appear when the water is near the top, due to hydrostatic pressure from the outside.

The magnitude of the work of protecting nearly 2000 miles of levees from Cairo to New Orleans in an emergency is a much greater undertaking than is generally understood by those not actively engaged in the work. A large proportion of these levees is from 1 to 2 ft. below the height reached by the 1912 flood, while much of the levee itself is built with an insufficient section, and constructed of material of the indifferent quality described above. This was the problem that presented itself all along the river during the high water in the months of April and May of this year.

The principal sources of danger to be overcome during a high water are the following: 1, danger from overtopping; 2, "sand boils" due to bad foundations; 3, sloughing due to saturation; 4, wave wash from rough water in wind storms. The methods employed in this work vary somewhat at different localities along the river, but in general are similar to the methods described below, which were employed in the district of the river between the mouth of White River, Ark., and Vicksburg, Miss., a distance of about 240 miles, known as the Third District.*

When it became evident that all previous flood heights would be exceeded by that of 1912, preparations were made by the different levee boards to maintain the levees against the threatened flood. They were assisted by plant, material, and labor forces under the supervision of the United States. The plant used for this purpose consisted of 4 stern-wheel steamboats, 2 steam tugs, 1 gasoline launch, 13 quarterboats, 30 material barges, and a number of skiffs. The levee lines on both sides of the river were divided in subdivisions of from 20 to 40 miles, and each subdivision placed in charge of a competent superintendent. It was necessary to raise 120 miles of the levees within these limits to meet the emergency due to the threatened flood. On Apr. 1, work was begun and by Apr. 12 these levees had been raised from 1 ft. to 3 ft. along the entire distance.

The methods followed (see Fig. 2) were as follows: At the lower end of the district, where there was sufficient time, the levees were topped with earth taken from borrow pits outside the levee proper. Teams and scrapers were used for this purpose. About 25 miles were topped in this manner. About 32 miles were topped with earth reinforced with lumber and sacks. For this work, a bulkhead was built of 1-in. plank, held in

FIG. 5. A SAND BOIL AT FOOT OF SLOPE, LOOPED WITH SACKS

place by stakes 2x4 in., driven in the top of the levee. The bulkhead was made from 12 in. to 24 in. in height, backed up and reinforced with earth shoveled from the inside of the crown of the levee or brought from the top edge of the ban-

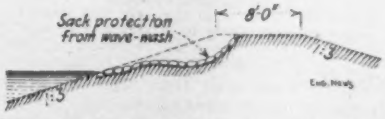


FIG. 6. LEVEE PROTECTED AGAINST WASHING ON THE WATER SIDE

quette where necessary. This earth was closely packed against the bulkhead, and at places where necessary, sacks filled with earth were used in addition. In Fig. 2, section A shows the levee topped with earth and section B shows the method of temporarily raising the levee with a plank bulkhead.

About 70 miles of levee was raised by using sacks filled with earth. The method employed was to plough the top of the levee first in order to get earth to fill the sacks. These were laid in one or more rows parallel to the line of the levee on the outside, the tiers of sacks being superimposed on each other with a core of tamped earth between, or else the sacks were laid close together. The number of rows and width of foundation of the wall of sacks depended upon the height that it was necessary to raise the protection work. Sections C and D of Fig. 2 show the methods of raising a levee with sacks. After the levees had been thus raised, there were stretches of several miles where the water stood against the sacks from 1 to 2 ft. above the top of the original levee, as in Fig. 3.

The first of these three methods is the most economical whenever there is sufficient time available, as the earth placed is a direct addition to the levee section, being taken from sources outside the levee proper. The second method, that of a bulkhead built of lumber, is cheaper than sacks for temporary work, and answers well when the levee does not require raising more than a foot or two. The third method, using sacks exclusively, is the most expensive. But where the levee requires raising 2 ft. or more, where the limit of time is short, or where teams are not available or cannot be worked on account of saturation of the back slope of the levee (making it dangerous to the stability of the levee itself to use them), dependence is placed on sacks filled with earth. They can be filled at points where earth is available and transported by barge often directly to the place where the topping is being done.

SAND BOILS

These are due to leakage through the levee itself, or between the base of the levee and the natural ground, or through the foundation under the natural surface of the ground. In the first case, the leak when well up the slope is sometimes stopped by placing fresh earth on the river side, which is drawn into the opening and seals up the leak. This method is often used in the lower part of the river.

When the leak is at the base of the levee, accompanied by the flowing and boiling up of sand in considerable quantities, the opening is encircled with a wall of sacks carried to a sufficient height to overcome the head of water on the outside; these walls or loops are from 6 to 30 ft. (or even more) in width, length or diameter, as the case may be, and from 3 to 10 ft. in height. Where the boils show up contiguous to the levee, subbanquettes and sub-levees are the most feasible methods of treatment. But during high-water emergency the conditions are seldom such as to allow sufficient time to follow this plan, and reliance is then placed on walling or encircling the

*An article on the Mississippi River levees and the flood of 1912 was published in Engineering News, June 13.—Ed.

most threatening boils with sacks as the most satisfactory treatment. This is shown in Figs. 4 and 5.

Sloughing of the Back Slope

After a long continued pressure of water against the front of the levee in places where the material is porous and the levee becomes saturated from heavy rains, sloughing or slipping of the back slope sometimes occurs. This often takes place where the enlargement to the levee has been made on the land side, due probably to imperfect consolidation between the new work and the original levee. This sloughing sometimes extends to the crown of the levee, and half or more of its width may be destroyed. The only temporary repairs possible to prevent disaster is to add weight and provide some means for draining off the water seeping through the body of the levee where the sloughing has taken place. Earth with which to do this is difficult to procure, and would have to be transported by hand labor, as the condition would not allow the working of teams.

The common practice is to cover the slope with a layer of brush or small poles, laid with their ends up and down the slope, in order to allow the leakage to flow down the slope without further injury. This layer is then weighted down with sacks of earth to hold the brush in place and give additional weight to support the weakened levee. Defects of this description are numerous after the levees have become saturated where the section is insufficient, and especially is this the case where enlargements have been made to the land side. Fig. 1 shows this method of treatment.

Wave Wash

In exposed reaches where the levee is subjected to direct action of the waves during a storm of long duration, it is frequently necessary to protect the front slope above the water line in some manner as a temporary expedient. Sacks of earth are generally used as being the best method available. A wind storm of 24 hours' duration has been known to destroy more than half of the width of the crown by wave-wash action in a levee of light material and in an exposed position subject to the direct impact of the waves. Bulkheads of boards have been tried with unsatisfactory results, and the dependence in emergency is sacks. Fig. 6 shows a levee protected in this manner.

Labor and Cost

In the protection work above described at least 10,000 men were employed. This labor was obtained principally from the landowners along the river, who turned over their plantation labor and teams to the levee boards in the emergency. In addition the services of 800 convicts were procured from the different states. About 1,250,000 sacks were used and the entire protection work cost about $250,000.

General Condition of the Levees

When it is considered that this district represents only 187 out of 1800 miles of the entire length of the levees, the cost of protecting the entire line represents such a large sum of money (which adds practically little to the permanent improvement or size of the levees) that the necessity from an economical standpoint of enlarging the levees so as to be of sufficient height and strength at the earliest time possible is evident. The only levee district where the levees were of sufficient height and section to have withstood this flood was the Upper Yazoo, which has 98.5 miles of levee on the east side of the river, beginning a short distance below Memphis, Tenn. Besides these, there are short stretches along the levees on both sides of the river where the section is ample, being up to the grade established by the Mississippi River Commission. But this represents only a small portion of the entire line.

This emergency work is of the most simple character, but needs careful direction from those with experience. It requires a large force of men and a large amount of material, which it is necessary to assemble and distribute under short notice, as from a week to ten days is generally all the time available to do the bulk of the work. These high waters occur at irregular intervals of from three to five years, and their magnitude can be forecasted only a few days in advance, as they are due to excessive precipitation in the watershed of the Ohio, Missouri, and Mississippi Rivers above Cairo. Hence it becomes imperative that quick action be taken to prepare for the emergency. Large expenditures will be required for protection work during threatened floods until the levees are brought up to sufficient height, with an ample section for stability and safety. What is needed is "more dirt."

A Concrete Dam at a High Altitude is being built by the city of Boulder, Colo. The dam, which is located at an elevation of more than 11,000 ft., will store water for the supply of the city. At the high altitude named, work can be prosecuted during only about three months of each year. The work was begun in the summer of 1910 and is being carried forward but will not be completed in the present year. The dam as planned will be about 60 ft. high and 600 ft. long on the crest, and will contain about 16,000 cu.yd. of masonry. Prof. Milo S. Ketchum, of Boulder, is engineer for the city, which is building the dam by day labor. As the winter temperatures at the dam go down to 40° F. and even lower, and the summer temperatures are frequently below freezing, the construction and maintenance of the dam present problems of unusual interest.

The Skilled Supervision of Sewage Purification Works*

By F. Herbert Snow†

For purposes of discussion, sewage-disposal works may be divided into four classes: (1) the town plant to serve the city, borough, township, village or hamlet; (2) the hospital or institutional plant; (3) the plant for a private estate; and (4) the plant for the industrial establishment in which trade wastes are handled.

Also for convenience it is premised that the sewage works have been properly designed and carefully built and are capable of performing the work put upon them, provided the plant be properly operated. The majority of plants are not properly operated, nor properly designed and built.

With respect to all four classes of plants, it will be agreed that lack of attention to the proper operation thereof will result in failure, sooner or later. In consequence there may follow a nuisance or a menace to health, or both; but always a failure means a waste of money.

The citizens of many of the states of the Union have determined it to be good public policy by statutory regulation to provide for the abatement of nuisances and the protection of water-supplies and in the furtherance of this policy to establish central control of water and sewage works. What can be the sense in enforcing these laws where the constructing of sewage-purification plants is involved if such plants when built are not to be efficiently operated and maintained?

Negligent Operation of Small Plants Particularly Notable

Now with respect to the hospital or institutional plant and the plant for a private estate, while it is true of both that neglect in operation speedily results in a nuisance, it is particularly true of a private estate. Engineers of high reputation avoid and not infrequently refuse absolutely to have anything to do with the designing or building of a sewage-disposal plant of this class. Where there is positive assurance worthy of acceptance that the plant will be faithfully operated, the engineer may furnish the plans, superintend the construction, and, leaving written instructions covering operation, depart feeling reasonably certain that the results will prove satisfactory to the owner and to himself. This exception is a rare one. Usually the plant is neglected, failure comes, the engineer is blamed and the profession suffers.

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*Abstract of a paper read before the American Public Health Association, Washington, D. C., September, 1912.

†Chief Engineer, Pennsylvania Department of Health, Harrisburg, Penn.

No wonder then that an engineer careful of his reputation is cautious about having anything to do with disposal works for private estates and that this class of service has been taken up largely by contracting firms and corporations. Companies of this kind have circulated descriptive pamphlets of sewage-disposal works adapted for private estates or hospital installation. Thousands upon thousands of such works have been built under guaranty of successful operation; but this guaranty may be fixed to expire well within the period subsequent to which a failure is inevitable. In consequence not a fatal but a serious blow has been delivered against the popular acceptance of modern methods of sewage purification. Prominent citizens, because of unhappy experiences with the disposal of sewage on their own estates, have exerted their influence with voters against the proposition to increase the municipal bonded indebtedness to defray the cost of building a system of sewerage and sewage disposal for the town.

What Proper Attention for Each Class of Plant May Embrace

For the private estate, an occasional inspection by an expert and his written instructions to the owner or operator should be sufficient.

For the hospital or institutional plant, occasional inspection by the expert, supplemented by such supervision as he may give in writing after looking over the reports of daily operations of the plant furnished to him weekly or monthly by the attendant in charge should be sufficient. Under such supervision, an attendant of ordinary intelligence should be competent to secure satisfactory results. By this system of skilled supervision over the work of the daily attendant in charge, all the care necessary may be provided. The frequency of the expert's visits and of his perusal of the reports of daily operations, and the nature of his written instructions must depend upon the size of the plant, its type and location.

For trade-wastes disposal it is quite probable that the situation may demand an expert in charge.

For the large town plant, where the works are for a large municipality, constant expert attendance, a laboratory and the making of daily tests and records are required. It is a question where the line should be drawn between works demanding constant skilled attention and those demanding no constant skilled attention. This question must be arbitrarily determined. The type of plant, the work to be accomplished—whether the object be the prevention of a nuisance or the protection of a public water-supply—the size of the works and amount of money involved, all are factors of greater or less value, varying at different sewage works, which must be considered in reaching a rational conclusion as to whether skilled supervision shall be constantly employed on the premises.

For a small town plant, situated on a small stream above a water-works reservoir or intake, where the high degree of purity demanded and where the local topography and geological formation precludes the use of any but works of the type that easily fluctuates in efficiency 40% on temporary neglect or oversight in operation, it is obvious that responsible skilled supervision must be employed.

The same is true with respect to the plant for the village or hamlet; but in these latter places the amount of money involved is small and the financial ability of the users of the sewers would be proportionately overtaxed were a skilled attendant to be constantly employed on the premises. Hence, satisfactory results must be secured in some other way. It is not alone a question of efficiency in results, but also a question of finance.

In small communities the question as to the feasibility of sewers at all is involved. Possibly, cesspools and privy vaults and control of night-soil disposal are methods more practicable.

On the other hand there might be a large town amply able to employ constant expert service where the object of the sewage works—the prevention of a nuisance—involves largely the question of sludge disposal. In such a case the kind of expert supervision over the man in daily charge required for the individual estate may be sufficient.

State Control

Building contractors, plumbers, manufacturing corporations, railroad and transportation companies, doctors and lawyers are under state regulation. The engineer alone remains without the pale of state control. There is no argument whatsoever in support of this situation if the regulation of affairs of other professions and trades be good public policy. There is a growing sentiment in several states in favor of the enactment of law, and it should be as uniform as practicable, making it compulsory for public authorities having charge of water-works, sewerage systems and disposal works and other public works, to employ on those works only such engineers and attendants as have been certified by the state as competent. Why so many comparatively trivial matters should be regulated by state law and yet so important a thing as the construction and operating of water-works and sewerage systems and disposal works, dealing as they do so intimately with the health of every individual of the town, has meantime escaped the attention it demands, is accounted for perhaps very largely by the fact that engineering is a new profession and that it has had hardly time to ponder the problems of its own existence as the older professions have done.

How far should the state go in exercising supervisory power over the operation of sewage works?

In a number of states sewage-purification works are rarely built except under compulsion. In Pennsylvania the Commissioner of Health decrees, under agreement of the Governor and Attorney General, when sewage works shall be built, and the municipality, corporation or individual, recipient of the decree, may appeal to the courts from the decision and decree of the state authorities, and the order of the court is final. The point I wish to make is, however, that the initiative rests with the state health authorities. Men fitted by training and experience determine what is prejudicial to the public health and wherein the interests of the public health must be conserved, since no other than men of this type are competent to perform this professional service. To offset the possibility of arbitrary judgment becoming tyrannical, appeal to the courts is provided, but whether or not the court be the final agency through which the power is exerted is immaterial; back of it all is the police power of the sovereign state which can compel the building of sewage-purification plants and can be extended to regulate the supervision of their operation, in order that they shall accomplish the object for which they were built.

If the owner of the plant chooses to employ constant skilled attendance, where occasional skilled supervision would be sufficient, that is his own concern only, but where the said owner refuses to employ any proper attendance whatsoever he must be compelled to do the necessary thing, and the state, in exercising this extension of its police power intelligently, must base its decisions on facts and information collected through systematic oversight of the operation of sewage works, this oversight being supplementary to, but not a substitute for, that which the owner of the plant should employ.

The sewage-disposal expert is not hindered in his service under this method of state control, but his professional interests are aided and abetted thereby. Up to this point there should be no debate as to policy; but beyond this point each state must work out for itself how far it shall go in this work of supervising the operation of sewage-purification plants and in establishing standards of operation and reports.

Statistics of Operation the Foundation of Efficiency and Economy

It is indispensable to the general welfare to know just how and where money-waste with respect to sewage works is occurring and whether it is on the increase or decrease. Such knowledge can

come only from statistics. It is the duty of citizens everywhere to stand for efficient registration of data relative to sewage-disposal operations. Sanitary engineers, above all others, should make themselves conversant with statistics and the science of their interpretation.

Statistics relative to morbidity and mortality from all causes, gathered by local, state and national bureaus, are accepted as necessary. Why not the same attitude toward statistics of operation of the public works built to prevent disease and mortality? In at least one state the owner of sewage works is required to keep a register of daily operations at the plant and to transmit copies thereof every month to the State Health Department. These data are the very foundation for accurate knowledge. Where such registration is brought to the highest proficiency, the greatest progress in efficiency and economy will occur.

There should be uniform registration of data relative to sewage-works management and operation. To accomplish this result there must be compulsory obedience to the reasonable requirements of law or infliction of a penalty in cases of violation of the law.

Chemical and Bacteriological Data Necessary

So we see that where skilled supervision is, there is collection of data also. Should there be chemical and bacteriological analyses as a part of the statistical data of operation? Yes, from a general standpoint; but both should be dictated as to nature, extent and frequency, by local conditions, of which there is a wide range.

By whom should these laboratory tests be made? Naturally the state should make some tests directly and others indirectly by regulating what a local laboratory report should cover. The town laboratories erected at or maintained in connection with the sewage works and other municipal departments would naturally be employed also. The private laboratory may be called into requisition, as at an institution or occasionally for the individual plant owner, or the small town.

The type of plant and local circumstances must determine the kind of test to be made.

(a) For instance, where the problem is one of sludge disposal and the dilution of the liquid to obviate a nuisance, physical tests should be made daily, weekly or monthly to determine the amount of suspended solids in the raw and settled or treated sewage, measurements of the volume of sewage treated and of the river or body of water into which the effluent goes should be made and also simple chemical and bacteriological tests to roughly indicate the work performed by the artificial process as a practical aid to Nature's process of purification in the river.

(b) Where the object of the plant is to protect a public water-supply, more data are required. Chemically, it is desirable to know, with respect to the solids treated, the amount suspended in the raw sewage and the amount removed therefrom: (1) in the tanks; (2) in the filters; (3) in the resettling tanks; and the amount remaining in the effluent, if any; also the condition of the solids, whether organic or mineral, putrescible or inert.

With respect to the liquids treated, it is desirable to have bacterial analyses of the raw sewage, of the filtrate and of the effluent from the plant. Presumptive tests are not sufficient; actual counts must be had for comparative purposes. Often local conditions must determine whether to examine the raw sewage or filtrate, but it is always important to examine the final effluent. It is usually helpful to know the efficiency of the filters, tanks and sterilizing process, as units. There should be colon determination for the final effluent, also putrescibility tests whenever a chemical germicide is used.

Not infrequently at institutions and hospitals is to be found a laboratory easily adapted by the resident chemist or pathologist for sewage analyses. This scientist can make the simple tests at the plant daily and the more complex ones less frequently; but for the private estate simple chemical and bacteriological tests every month may be sufficient. Local conditions must control.

For the town, the simple tests should be made daily and the more difficult ones daily, weekly, or as advisable, depending upon the size of the works and other controlling circumstances.

For trade-wastes disposal, the whole object sought may be the profitable reclamation of ingredients, or it may be largely a matter of avoidance of a nuisance, or it may be directly or indirectly the protection of the public health; directly, as where anthrax infection of a public water-supply comes from a tannery; indirectly, as where paraffin, or creosote, or acid, or coloring material, in raw water operates to render water filters inefficient, to the prejudice of the public health, thus interfering with a necessary and important and all-essential use of waters that in their natural state are potable.

Conclusions

The art of water purification is not keeping pace with the increasing pollutions of the sources of water-supply in some districts of certain sections of the country. [Several paragraphs here omitted had as their burden the suggestion that as yet we have little expert knowledge as to the effect of waters of different kinds on the health of individual consumers, but that there is reason to believe that unknown or little known deleterious effects may arise from the introduction of foreign matters to drinking water, quite regardless of possible infection with disease germs.—Ed.]

We all would prefer a clear, soft, natural water, comparatively free from mineral constituents and organic life. It is impossible to obtain such water in many places, and artificial methods have to be resorted to. The proposition which I submit is that it is better to keep foreign ingredients out of the natural waters, if this can be accomplished by a feasible plan, more particularly with respect to ingredients discharging into sources of supply from industrial operations and sewers. The baneful effects of trade-waste pollutions may be readily manifest to the senses of sight, smell and taste. The baneful effects of sewage pollution are sometimes strikingly manifest in a startling outbreak of a typhoid or other epidemic of water-borne origin. The bacteriologist will state how many sewage organisms may be found in a given volume of the raw water. He may find the sewage organism in 1 c.c. or he may find it present in 3, 5 or 10 c.c. He will not guarantee that the typhoid germ is not lurking in the supply, even though he may not be able to detect it in his sample.

Within the last few years, with increased knowledge attained by observation of the working of water filters of different kinds, has come lack of that absolute confidence previously extant in the ability of the filter to remove harmful organisms. Today, hardly a filter plant in the country is being operated, regardless of type of plant, without the use of chemicals and germicides. If the germicide be not used constantly, it is held in readiness for emergency use, a recognized additional safeguard that the conditions demand shall be afforded to the public health.

It should be sufficient, without exposing the weak points in modern methods of water treatment or the limitations in modern bacteriological technic, for me to commend to your thoughtful consideration the proposition that the public health in districts where the people are supplied with water drawn from streams receiving sewage demands a double safeguard. The first barrier to the spread of the infection reaching the stream as sewage should be in the treatment or control of the sewage at the point of discharge. "Kill the germ in the bed-pan" is the ideal that would wonderfully reduce typhoid fever, if it were feasible of accomplishment. The next best place to kill the germ is at the mouth of the sewer. The second barrier to the spread of the infection through water-carriage is at the water-works intake below, where a treatment plant adapted to the conditions is necessary. It is not sufficient

to rely on this water-purification plant. It has been demonstrated in Pennsylvania time and again that public policy demands the control of the discharge of sewage into the stream above the waterworks intake.

The Santa Maria Hydraulic-Fill Dam, near Creede, Colo.

A hydraulic-fill dam about a hundred feet high is being built twenty miles or so from Creede, Colo., to store water for use in irrigation near Monte Vista, Colo., many miles distant. Various companies are interested in the irrigation system, including the Rio Grande Reservoir & Ditch Co., which is building the dam, and the Colorado Valley Land Co., the owner of the land, and the Rio Grande Land & Canal Co., owner of the canal system to which the stored water will be delivered. We are indebted to Thos. W. Jaycox, Foster Bldg., Denver, Colo., for the information on which this article is based, and for the photographs reproduced by way of illustration. Mr. Jaycox is the chief engineer for the dam, and C. N. Phillips, of Denver, Colo., is constructing engineer. Frank C. Goudy, Symes Bldg., Denver, Colo., is president and manager of the several proprietary companies.

The canal system for which water is to be stored by the dam under consideration was constructed about 1886 or 1888. It is located in San Luis Valley, Colo., and draws water from the Rio Grande. To supplement the Rio Grande the waters of Clear Creek, with a drainage area of 100 sq.mi., are to be diverted through some 16,000 ft. of pipe and canal to a small body of water (30 acres in area) called Lakenan Lake; thence through a natural channel for ¼ mile to Lake Santa Maria (which is to be enlarged by the hydraulic-fill dam); thence through an outlet canal for about 3000 ft. to Boulder Creek, thence back to Clear Creek, thence three

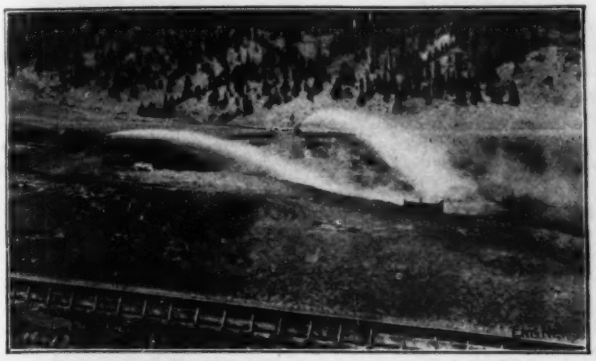

FIG. 1. HYDRAULIC GIANTS LOOSENING MATERIAL FOR SLUICING INTO DAM; A WINDY DAY

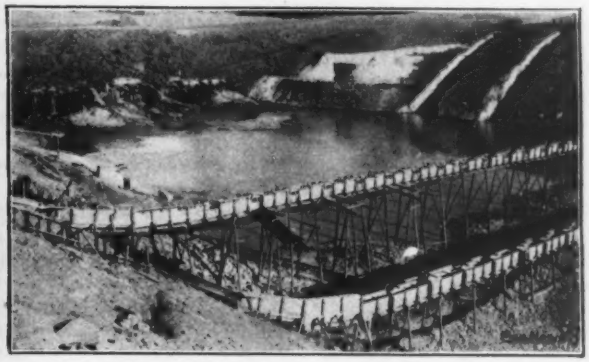

FIG. 2. THREE OF THE SLUICING AND DEPOSITING FLUMES, THE POOL AND THE TWO CUT-OFF TRENCHES

FIG. 3. HOW THE MATERIAL IS GRADED FROM COARSE TO FINE AS DEPOSITED

FIG. 4. GRIZZLIES DEPOSITING COARSE MATERIAL ON BACK SLOPE

FIG. 5. SHOWING LARGE SIZE OF STONE PLACED IN UPPER SLOPE OF DAM

FIG. 6. LOOKING DOWN CONCRETE CULVERT FOR DRAINING POOL

FIGS. 1 TO 6. VIEWS SHOWING CONSTRUCTION OF THE SANTA MARIA DAM, COLORADO, BY THE HYRAULIC-FILL METHOD

miles by that stream to the Rio Grande, and finally for some 60 miles down the Rio Grande to the intake of the existing canal system.

The diverting pipe line and canal from Clear Creek were built in 1911. The first 8000 ft. is a 48-in. Douglas fir continuous wood-stave pipe, under a maximum head of 175 ft. Half-inch steel bands are used on the pipe, spaced to correspond with the pressure. From the end of the pipe conduit there extends some 8000 ft. of concrete canal, rectangular in section, 5 ft. wide on the bottom and 4 ft. deep. The bottom is of concrete, 6 in. thick; the sides are also of concrete, 6 in. thick; the cover is a 4-in. concrete slab, reinforced with expanded metal. A little earth was scattered over the roof of the canal. The pipe conduit is buried in the earth. The concrete canal is in a trench, and is surrounded by earth.

The lower end of the canal, as also the surface of Lakenan Lake, is about 300 ft. above the water level of Lake Santa Maria. The last-named lake had no outlet when it was taken in hand for irrigation purposes. Its surface was then at Elev. 9388. About five years ago the level of this lake was raised about 16 ft. from 9372 by turning a small stream into it, through Lakenan Lake, but the lake level was still 20 ft. below the valley across which the hydraulic-fill dam is now being built.

The dam will have a maximum height of about 95 from crest to base, or about 100 ft. from crest to the horizontal plane passing through the lower toe. When full the water surface of the new Lake Santa Maria will be at Elev. 9485. The outlet is at Elev. 9390, giving 95 ft. of storage (water surface 8 ft. from dam crest).

The main dam will be about 700 ft. long on the crest, and will have a total crest length of 1300 ft. The top will be 20 ft. wide, the wetted slope 3 on 1 and the dry slope 2 on 1; and the water will come within 8 ft. of the crest of the dam.

The dam has two cut-off trenches (shown running up one of the abutting banks, Fig. 2). One of these is 10 ft. wide, 25 deep (to hardpan) and is sheeted. The cut-off trenches are filled with the fine silty material. All the silt used will pass through a 50-mesh screen, most of it through one of 100 mesh and about 90% through a screen having 200 meshes per inch.

Water for sluicing in the material composing the dam is taken from Lakenan Lake, through a ditch 500 ft. long, thence through pipes which give a head of 200 ft., more or less. There is a 30-in. main pressure pipe, branching into two 18-in. pipes. The latter branch to 12-in. pipes, which supply Hendy "giants" (Fig. 1). The nozzles are 3, 4 and 6 in. in diameter, but 4-in. nozzles are best adapted to the material which is being moved.

The dirt and boulders loosened by the hydraulic jets are conveyed to the dam by means of sluice boxes, 3 ft. wide on the bottom and 2 ft. deep down to the riffles; or 3 ft. deep altogether. The sluices were made from 1½-in. stuff and paved with 10-in. depth sawed blocks or else with round blocks. The blocks are placed on end. The round blocks are preferable to the square and are cheaper. Two sluices, with outlets for depositing the filling material, are carried across the working top of the dam, one on each of the temporary crest banks which, with the natural slopes at either end, form the pool. Fig. 2 shows one sluice on each side in or ready for use and a third sluice ready to be taken down.

As those familiar with hydraulic-fill dams know, the finest material goes to the center of the dam and the increasingly larger material is placed farther and farther away, the boulders going to the outer sides of the dam (see Figs. 3, 4 and 5). At the Santa Maria Dam no handwork is employed to place the boulders, except to trim the slopes.

To remove the water from the central pool into which the finest material composing the dam is deposited by the sluices, a concrete tunnel or conduit, 2 ft. wide and 3 ft. high, was built from the lower toe to the center of the base of the dam, then carried up the natural slopes at the north end of the dam. Fig. 6 shows the conduit extending up the slope of the abutting bank. The conduit is covered as the surface of the pool is raised, and the open sloping top may be covered temporarily with planks as needed to control the depth of the pool.

The outlet from the lake or reservoir is a concrete-lined tunnel, 614 ft. long, 6 ft. wide and 6 ft. high to the springing line of a segmental arch which has a rise of 1½ ft. The outflow is controlled by means of two lines of 48-in. pipe, with two 48-in. gate valves on each, and by a single line of 36-in. pipe, also provided with two valves. The valves are placed about 6 ft. apart, in a chamber in the tunnel. They can be operated by hand or, when the head is sufficient, by hydraulic power.

The total volume of material to be placed in the Santa Maria Dam will be about 310,000 cu.yd. Construction on the dam was begun in May, 1912. Three eight-hour shifts were worked, with meals served on the job, until Aug. 15, when two ten-hour shifts were used, as it was found that the latter way was productive of better results. It is hoped that the dam will be completed by August, 1913. From May 4 to Aug. 31, 1912, there had been placed 131,000 cu.yd. of material in the dam.

The contract for the dam and the pipe line and canal which diverts water to Lakenan Lake was let to MacArthur Brothers Co., of Chicago. The hydraulic-fill construction was sublet to Johnson, Locher & Co., of Seattle, and is in charge of H. O. Locher, of that company.

Winter Troubles on Electric Railways*

By Charles J. Jones†

The operation of electric railways in sections of the country where there is little or no snowfall, differs but little from the regular performance at other seasons. Where the winter is a rainy season of a few months the problem becomes one of railway construction, requiring waterways of sufficient number and capacity and properly located so as to avoid breaks in the roadbed due to washouts. In our northern districts, where the snowfall is of some importance, the question of maintaining the schedule in winter becomes at times a difficult one and a source of anxiety. Snow, sleet, ice and frost are the trouble makers, and the manager who contends successfully against them is the one who has made full preparation before the winter had made its appearance.

The maintenance-of-way department should see to its waterways and bridges. Where pile bridges are maintained over streams, such tools and explosives as may be necessary to protect the supports from ice should be on hand and ready for use. Heaving of track by frost is a menace to the safe operation of trains, and is a frequent cause of delay to the service. It seems almost impossible to obviate this trouble entirely, but as it is usually the result of poor drainage, it is important that all ditches in the cuts should be cleaned before the frost comes. Certain cuts cannot be drained properly by the ordinary ditch, and it then becomes necessary to lay drain tile a few feet below the ditch in order to draw away the moisture from the subsoil.

Sleet and ice coupled with high winds are serious factors to be considered in the proper maintenance of transmission lines and the assurance of a continuous supply of power. Poles and crossarms should be carefully inspected and strengthened where necessary; new insulators should replace doubtful ones, and all wires (telephone, trolley and transmission) should be looked over and the weak places made strong. On lines where the third-rail takes the place of the trolley wire, the same careful inspection should be made and proper attention given to the insulators, underground cables (with the necessary drainage thereof) and the cable terminals. The loss of power for a short time during the progress of a winter storm may mean the loss of train service for many hours.

Snow Fences and Snow Plows

The handling of snow may be considered under two heads: 1, Methods of

*Abstract of a paper read before the Illinois Electric Railways Association at Chicago, Sept. 20.

†Chief Engineer and Superintendent of Transportation; Aurora, Elgin & Chicago Ry., Wheaton, Ill.

preventing snow from accumulating; 2, Methods of removing snow.

Methods of the first class as applied to interurban lines include the widening of cuts and the use of snow fences. Where trouble from snow drifts occurs annually, a permanent board fence may be erected in place of the usual right-of-way wire fence. Frequently we use boards nailed to the regular fence, supporting them by nailing to the fence wire and to an intermediate post. Portable snow fences may be set out in the fall and removed in the spring. These are usually made in panels about 16 ft. long and 6 ft. high, and should be set from 50 to 100 ft. from the track.

As a rule, landowners do not object to allowing these fences on their land, but in some cases compensation is demanded. A wise forethought while securing right-of-way, has in some instances provided for the right to use portable snow fences on the adjoining property, and where possible this should always be done. These fences cost about 25c. per lin.ft., and when properly placed are extremely valuable in preventing the snow from drifting into the cuts. As the snow piles up around them, these fences can be raised on the drifts or set farther back as occasion warrants.

There seems to be no reason why the usual wire right-of-way fence should not be replaced in places subject to snow drifts by hedges of osage orange, honey locust, Japan privet, tartarian honeysuckle, or other hardy growth, which could be kept trimmed to fence height. In addition to acting as a partial protection against drifting snow they would make a permanent right-of-way fence, neat in appearance and effective in preventing cattle from passing through.

Methods of the second class, referred to as the "removal of snow" are various. They include many devices, from the man with the shovel to the light rail scraper and the powerful mechanical plow. The man with the shovel is not to be disregarded, as he is an essential factor in any snow-fighting equipment. His limitations, however, are apparent to anyone who has attempted to clean snow from track with a hundred and more men in the face of a gale of wind, the air dense with drifting snow and the temperature about zero. He no doubt has felt not only the effect of exposure to the storm, but also that of discouragement when, upon looking back, he has found that the section just cleared from snow was again full.

On city lines it is usual to equip the cars with scrapers, which are under the control of the motorman and so arranged that the blades are held on the rail under pressure. On all unpaved streets and highways it is important that the mud and dirt should be scraped aside and leveled down to the rail before it becomes frozen. If this is not done, the scraper will not be able to reach the rail and the motor and gear casings will be dragging on the high places.

The rotary broom sweeper is used especially on city lines and, being very effective, should be included in the snow-fighting equipment of all companies operating cars on streets and highways. These sweepers may also be equipped with wings which push the snow beyond the range of the brooms. As the sweeper throws a cloud of snow it is important that it should be operated by men of good judgment, as the flying snow is very likely to frighten horses. The electrical equipment to operate these sweepers varies according to the ideas of the purchaser, but the mistake of having slow-speed motors to drive the brooms should be avoided.

On lines operating on private right-of-way in the open country the high V-shaped nose plow and center-share plow prove to be highly efficient. These plows also are equipped with adjustable side wings to push the snow farther aside. These types of plows practically force their way through the snow and the secret of their success is weight of car and high speed. They should have the speed of the fastest passenger car on the system, in order to be able to run ahead of the regular cars and keep clear of them, and also for the purpose of clearing a larger track mileage. The writer has passed through snow drifts varying from 2 to 10 ft. deep and 2000 ft. long with a snow plow of the center-nose type built on a flat car 34 ft. long (50 ft. over points of plows), with wings open to clear a width of 11 ft. It was weighted down with rails and old iron; equipped with four 125-hp. motors, and geared to a speed of 72 mi. per hr.

Passenger, freight and express cars are frequently equipped temporarily with a small nose-plow attachment, and are able to cut their way through snow that otherwise would stop them. In sections where the snow conditions are severe, the rotary snow plow is much to be desired. This type of plow has a large pan or hood in front, with spreading wings to collect the snow as the car is driven forward. Within the hood is a revolving wheel fitted with blades which cut the snow and carry it upward, throwing it a considerable distance to the side.

The movement of cars through snow soon forms a crust which becomes harder as the motor casings continue to drag on it. This hard center not only checks the speed of the cars but causes a loss of power in proportion to the extent to which the casings ride on it. This condition becomes at once apparent if a car having smaller wheels than the others is run over the line. When such a car comes to the hard centers it soon stops, and efforts to move it bring only spinning wheels. Upon examination it is found that the motor casings are riding on the crust of snow and raising the wheels from the rails, destroy the traction effort. To remove this hard center we have the scraper and flanger, which is usually lowered and raised by compressed air. In some cases a device with steel points arranged in the form of a tooth harrow is used successfully to break down the hard center. In congested terminals and streets where the snow can no longer be pushed aside by the wings of snow plows, etc., it becomes necessary to load it on wagons or cars and haul it to the most convenient place for unloading.

Organization for Fighting Snow

Snow storms vary in intensity and in kind, and it is hardly possible to depend upon a single type of snow plow or sweeper to overcome them all. Certain types of plows are better adapted to control certain storms. To have at command any or all of the above mentioned snow-fighting devices is not alone sufficient; there must be organization for the work. The organization should be carefully planned in advance and the men included therein fully instructed and trained, so as to avoid confusion or misunderstanding when the emergency arises. Men trained to a particular work of this kind should be kept there, if possible, as experience is a valuable asset. The men should be instructed to report for duty immediately upon the first snowfall and be ready to take charge of the work allotted to them. The superintendent or officer in charge should be where reports of progress or difficulty can reach him promptly, so that he can act in accordance therewith with precision. The work must be started with the appearance of the storm, without waiting until reports come in of the cars being stopped.

Having an organization and equipment, it is also important that the equipment be thoroughly overhauled and put in condition for immediate service at the beginning of winter. When the threatened danger has made its appearance, there is no time for repairs or the purchase of shovels and brooms or plows. A contest against the storms of winter is war, so let us follow the adage "In time of peace, prepare for war."

A Continuous Weighing Device for belt and bucket conveyors, cableways, etc., has been designed by H. L. Merrick, of Passaic, N. J. A portion of the conveyor length is supported by a floating frame attached to the weighing levers of a scale system. The load on this length of conveyor is counterbalanced by an iron cylinder suspended from the end of the scale beam. This weight dips into mercury and gains or loses total buoyancy to compensate for load changes. The movement of the beam end is proportional to the load and is recorded on a continuous chart, the travel of which is made dependent on the speed of the conveyor belt or haulage cable.

A Sliding Scale for Street Railway Dividends Based on Quality of Service*

By James W. S. Peters†

To the average citizen quality of street-railway service is far more important than the rate of fare. Justice and good service alike demand that investors should receive a fair return on capital invested in street railways. In order to reward the service rendered by street railways according to its quality it is necessary to find out what service really is and then definitely to grade or scale this service and reward it.

To this end it is suggested that the mayors of cities or the commissioners of commission-ruled cities each year appoint three citizens of repute, who shall during the year following classify to their satisfaction the elements constituting service and determine in percentages the relative value of its essential elements. At the end of the year, these three commissioners shall appoint for each of the at least five logical subdivisions of service analyzed and classified by them, three other reputable citizens, especially expert in those subdivisions, to grade for the year preceding the character of service received during the year past; the subdivisions of what constitutes service into subjects and the grading of the subjects to be arrived at in a way similar to the method pursued by civil-service commissions in determining the relative merits of applicants for technical positions of the city service.

I suggest grading the service of street railways and the ultimate elements constituting such service as follows: 60 meaning "poor," 70 "fair and reasonable," 80 "good," 90 "excellent" and 100 "perfect."

If we agree that 6% on capital investment is a fair and reasonable return for the interest upon capital and the hazard of the enterprise and are willing to add a margin up to 25% additional to insure "perfect" quality (which, however, will never in practice be attained) then we can agree that a standard of 60% will be entitled to 5½%; 70 to 6%; 80 to 6½%; 90 to 7% and 100 to 7½%. If those drawing the franchise think this varying margin too great or too small, it can be readjusted and the figures modified accordingly.

When the end of the fiscal year comes and the several citizen commissions of three each have been duly appointed to grade the several parts or subjects of service committed to them by the original or supervisory committee of three citizens each commission shall proceed to grade the part committed to it by such tests as in its discretion it deems appropriate, subject to general supervision of the original commission of three, and when it has agreed to a grade of its portion, shall transmit this grade to the original commission. This commission shall then by checking up and adding the various percentages arrive at a final percentage figure which will be the grade upon which to figure the reward for service.

As a tentative subdivision of service into five parts and their relative weights, for each of which a sub-committee may act, it is suggested:

(1) Operation and Management: value, 40%.

In this case the three citizens selected should be expert in railway operation and management.

(2) Maintenance of Plant against Depreciation and Obsolescence; value, 20%.

This subdivision is essentially an engineering task and involves an inspection and inventory and practically the valuation of the plant. It is desirable that at least two of the citizens selected for this sub-committee should be expert engineers, especially qualified by experience in street-railway construction and management and having at hand data in reference to the depreciation and obsolescence.

(3) Economy and Efficiency of Management: value; 15%.

The three citizens selected for this subdivision should two of them be business men of high caliber, accustomed to the handling of large affairs, the other member familiar with accounts and legal procedures.

(4) The Safety and Comfort of the Traveling Public and of the Citizens; value, 15%.

As this subdivision is largely a matter upon which the riding public and the citizens have peculiar right to individual opinion, the committee of three selected for this subdivision should be average citizens, in whose fair dealing and common sense, both the corporation and the public have confidence.

(5) Accuracy and Publicity of Accounts and System in Preserving the Funds Intact; value, 10%.

This subdivision is a matter for experts in accounting. At least two of the three commissioners for this subdivision should therefore, be familiar with accounts and auditing systems, while in order to complete the commission, the other member should be a well known responsible citizen, accustomed to handling large affairs in a practical way.

There should be given to the several sub-committees of examiners large discretion in determining the methods and details of arriving at a fair and accurate estimate and they should have access to all records kept by any existing public-utility commission or other board having charge of the street railways, and also to the company's books, accounts, records, maps and plans and other documents.

The public-utility commission should collect during the year and put at the disposal of these special commissioners data collected from efficiency and complaint records kept by them. Any citizen desiring so to do should be [illegible] ted to register a complaint and file [illegible] ments and be heard in reference to any matter pertaining to service before either the original committee of three or before any of the sub-committees of examiners subsequently appointed. The original committee of three and the sub-committees of examiners should hold sessions open to the public and the press and should print and publish their proceedings, showing among other things the definite rating of each of the ultimate elements constituting service; such publicity will tend to assure fairness and accuracy.

When a final grade is arrived at and used as the basis upon which to figure the amount of reward to the capital investment, it is a question whether this bonus should go entirely to an increase of the percentage allowed on capital investment or should be shared with the employees of the managing corporation, who in reality are the persons accomplishing the good results. The best plan undoubtedly is to see to it that the increase in returns derived by reason of excellence of service be divided between the capital investment and its employees: the employees to receive one-fifth of the whole and the other four-fifths to be added to the fixed return on capital investment. The amount received by the employees should be pro-rated among them, from the president and general superintendent down to the day laborer on the tracks or in the shops, at the end of the fiscal year, in proportion to the amount of salary or wages received by each during the year in question.

To go back to the details of our problem, if we agree that 60% means "Poor" as the quality of each of the ultimate elements; 70% "Fair and Reasonable," 80% "Good," 90% "Excellent," and 100% "Perfect," it is evident that when the several weighted elements are separately graded and a total of these percentages computed, we will arrive at a figure signifying with considerable accuracy the general average quality of total service furnished. For example: if the final percentage of service be 82.5%, this would be 12.5% better than 70%, which is "Fair and Reasonable." Now, if we take for granted that "Fair and Reasonable" service estimated at 70% is worth 6% return on capital and that perfect or 100% service is worth 7½% returns, this 12½% above "Fair and Reasonable" would amount to a bonus of ⅝ of 1% on capital investment.

Using these figures in the case of a plant where the capital investment aggregates $30,000,000 and the gross annual receipts are $6,000,000, this would amount to a bonus of $187,000, ⅝ to go to employees and the other ⅜ to an increase of the capital investment. This in dollars and cents would be $37,500 to pro-rate and distribute among the

*Condensation of a paper read before the National Municipal League, at Los Angeles, Calif., July, 1912.

†Kansas City, Mo.

company's employees and $150,000 increase on the return on capital investment. The possibility of such a result would undoubtedly be an incentive to skill, initiative, economy, politeness and thrift in service and management, and in the case supposed, would be an additional tax of approximately only 1/2 of 1c. on every five-cent fare paid, or proportionately less, on a lower rate of fare.

The writer does not desire to make these suggestions as in his opinion the final or only solution of the franchise problem or to be supposed to take an antagonistic stand against the Chicago plan, where there is a partnership in the net income between the city and the corporation, after the corporation has received a fixed amount on its capital investment. This certainly insures in large measure supervision and control on the part of the city and gives ample incentive to thrift, economy and skill on the part of the management. Nor yet does he desire to oppose the Cleveland plan, where capital investment receives a fixed return and no more, the surplus being used to reduce the fare, for there the right of control and regulation, and machinery therefor to protect the city and enforce service is definitely provided for, but he merely presents the idea herein for what it may be worth, to be used, if deemed meritorious, in some degree at least in subsequent modification of such uptodate contracts.

If he does nothing more by this paper than to emphasize the fact that future franchises for street railways should give something in the way of incentive for economy and thrift in service additional to the mere interest return on capital and compensation incurred by capital for hazards risked, he will have accomplished something in helping to work out a finally satisfactory solution of the street-railway franchise problem.

The Value of Publicity and a friendly attitude towards the newspapers is well shown in a report of the superintendent of water-works, Richmond, Va.:

> Much prejudice existed against the water-works settling basins when they were put into operation. Through the courtesy of the morning paper in Richmond, a synopsis of the working of the settling basins appeared each month. This synopsis gave the amount of water consumed for the month and cost of clearing it, and a discussion of the laboratory work. The afternoon papers published frequent articles. Information was always furnished the papers on request. A friendly relation with the papers has been established, and our notices usually have a prominent position. The public now seems to be familiar with the basins, and in a friendly attitude towards them. A copy of the regular monthly report submitted by the superintendent was sent to the chief health officer. A synopsis of this report appeared in the monthly bulletin of the Health Department. Starting on the first day of March, and continuing every day in the month, a bottle of water from James River and a bottle of water from the reservoir were placed in a store window at Fourth and Broad streets. The display attracted much notice, and showed the public by contrast the improved appearance of the water from the reservoir, over water taken directly from James River on the same day.

Papers on Water Purification before the Central States Water Works Association

A number of papers dealing with various phases of water purification, particularly hypochlorite and ozone disinfection, were read at the meeting of the Central States Water Works Association, at Detroit, Mich., Sept. 24 to 26.* Summaries of these papers and of some of the most interesting features of the lengthy discussions to which they gave rise are here presented. For convenience the papers and discussions have been arranged without regard to their sequence at the convention.

MECHANICAL FILTRATION ACCESSORIES—"Some Improvements in Devices on Mechanical Filtration Plants," was the title of a paper by F. B. Leopold, engineer of the Pittsburgh Filter Co., Pittsburgh, Penn. The author described (1) the Earl coagulant feed regulating device, (2) a filter rate controller based on the principles underlying the Earl device, (3) a recording loss-of-head gage, and (4) a device for regulating the application of hypochlorite for water disinfection. The latter is practically a "valveless pump," adjustable as to stroke and definite measuring capacity, operated by the impulses of the service pump. This device was designed by Andrew Jacobsen, of Council Bluffs, Iowa, and has been used on the water-works of that city.

HYPOCHLORITES—In "The Treatment of Public-Water Supplies with Hypochlorites," W. H. Dittoe, Chief Engineer, Ohio State Board of Health, Columbus, Ohio, reviewed the history and technical features of the use of these disinfectants. Referring to after-growths of bacteria, he said that few reliable data on this subject have yet been amassed. It is thought that the after-growths are harmless. Other data regarding hypochlorites are also needed. Finally Mr. Dittoe said:

> In the present stage of development and knowledge of the process, it is unwise to define the province of its proper use, although it may be stated that this province is limited and that the treatment is not a universal remedy for all polluted water-supplies. While the advantages of the process are great, there are also to be considered important disadvantages, which may in some cases outweigh the advantages.
>
> In any case the treatment should not be used without the advice and superintendence of an expert having a sound working knowledge of the principles of the process.

Although entitled "The Great Lakes as a Water-Supply," an interesting paper by J. C. Beardsley, of Cleveland, was devoted mostly to water purification and most of all to the use of hypochlorites. The larger part of the paper dealt with conditions at Cleveland, and a large part of it consisted of the conclusions drawn by D. D. Jackson, in his recent report on the sanitary condition of the Cleveland water-supply.

A particularly interesting feature of this paper was a brief story of how a joint investigation conducted by committees of the Academy of Medicine, the local chapter of the American Chemical Society and the Cleveland Engineering Society [apparently under the leadership of the latter] headed off a stampede for a water filtration plant for Cleveland, for which a $1,500,000 bond-issue ordinance had actually been introduced in the city council. Mr. Jackson's report confirmed the conclusions of the joint committee that filtration was unnecessary and that the use of hypochlorites sufficient when any treatment was required.

The only Great Lake cities which have resorted to chlorination, Mr. Beardsley stated, are Erie, Cleveland, Milwaukee, Evanston and (temporarily) Toronto, while the latter is the only large lake city which has yet installed a water filtration plant—its intake extends "only 1400 ft. from shore in a somewhat enclosed bay."

Finally, Mr. Beardsley said that "it seems reasonable to assume that water drawn from a sufficient distance from the shores of the Great Lakes to avoid shore contamination and excessive turbidity is as near an ideal water-supply as we can hope to obtain at the present time by any known method of purification." Water taken within two miles of the shore, in the open lake, apparently needs purification "as long as raw sewage is allowed to flow into the lakes, and in the case of Lake purification "is made still more necessary by its shallowness and consequent liability to excessive turbidity during storms."

DISCUSSION OF HYPOCHLORITES — In answer to a question Mr. Leopold stated that his company expected to make the hypochlorite pump device of vanadium bronze.

H. L. Williams, of Ludington, Mich., said that at his works the State Board of Health put in a hypochlorite plant consisting of a mixing barrel and feed keg, which have since been replaced locally by a more suitable plant. About 7½ lb. of hypochlorite is used per 1,000,000 gal., to treat Lake Michigan water.

Mr. Beardsley called attention to the advantages of liquid chlorine gas as a substitute for hypochlorites, as recommended for Cleveland by Mr. Jackson. That city is thinking of making the change. The chlorine comes in iron cylinders and can be admitted from these to the water without other apparatus than a regulating device to adjust the rate to the volume of water.

Hans E. Seidel, chief engineer of F. J. Peck & Co., Cleveland, Ohio, spoke of a plant for introducing liquid chlorine installed at Fort Meyer, Va., by Major

*See Eng. News, Oct. 3, 1912, for report of the convention.

Donnell, of Washington, D. C., and a former city chemist of Youngstown, Ohio.

W. W. Brigden, superintendent of water-works, Battle Creek, Mich., agreed with other speakers in the belief that chlorination would not be injurious to the glove industry. Hypochlorite has been used at Grand Rapids since April without complaint from a local glove manufacturer. After trying many years to get his board to use hypochlorite before an outbreak of typhoid occurred (B. coli occurring now and then) he had at last succeeded.

When boats are running in the lake the organic matter is high and so much of it is absorbed by this that it is sometimes necessary to raise the dose to from 2 lb. to 12 lb. per 1,000,000 gal., the latter being the maximum permissible without trouble from taste and odor. At times the high amounts of vegetable organic matter take up so much of the hypochlorite as to leave too little to serve as a germicide. It would be advantageous to use sulphate of alumina to reduce the vegetable and mineral matter in the water. The hypochlorite has been useful in reducing algae growths.

OZONE—A somewhat commercially partisan paper on "Purification of Water by the Ozone Process" was read by R. M. Leggett, of the National Air and Water Purifying Co., Ann Arbor, Mich. The author prefaced his remarks by stating that the excessive cost of ozone treatment in Europe had been due to the mode of applying the ozone, which trouble is done away with by the apparatus which he promised to describe in his paper. Most of the paper was devoted to a general description of the ozone process, assertions as to the inefficiency of all other methods of water treatment, and equally positive assertions to the effect that in ozonization alone is there safety for the water drinker.

Municipal water organization plants of from 1,000,000 to 25,000,000 gal. per day were said to be in use at Paderborn, Munich, Astrakan, Marseilles, Dinard, Nice, Chartres, Indret, Chautenay, St. Servain, Arranches, Cosne, Sulina and Paris, besides a 3,000,000-gal. plant which has been in continuous operation at Ann Arbor, Mich., since December, 1910.

The author failed to give a specific description of the ozone apparatus which he said had solved the excessive problem, nor did he give any cost figures except a tentative estimate of $1 per 1,000,000 gal. for the ozone aeration of water treated by hypochlorite.

Discussion on Use of Ozone—Mr. Leopold [being in the mechanical filter business] naturally challenged Mr. Leggetts' broad claims for ozone and damaging assertions regarding filters. He "heard statements as thoroughly enthusiastic and as sincerely made in the past by the speaker and others who had been experimenting with ozone. Probably $1,500,000 has been spent in" such experimental work. The ozone plant at Lindsay, Ont., was found by the Provincial Board of Health to eliminate only 8% of the bacteria. The one at Baltimore (County Light & Water Co.) is still in an experimental stage, and while the engineer of the company feels that he is near success he is not ready to say so publicly.

If the Ann Arbor plant is doing all Mr. Leggett claims for it, Mr. Leopold urged, then the way to gain recognition for it is to place it in the "hands of one or more disinterested recognized authoritative experts" for operation, investigation and report.

Mr. Leopold seriously objected to the statement that filtration plants do not adequately purify water—barring exceptions in the way of poor design and operation. He urged that filtration plants "producing effluents with an average of less than 10 bacteria per c.c. and rarely isolated evidence of pathagenic bacteria are certainly attaining as near perfection in this art as has been the case in any mechanical art; and the possibilities of further improvement, even with the use of ozone are comparatively slight."

In reply to this challenge Mr. Leggett said that water should be made "free from disease-producing bacteria every hour of the day and every day of the week. . . . . All filtration plants are more or less dependent on the human element"—evidently implying that this is eliminated in ozone plants. Continuing Mr. Leggett said:

> Regarding the Lindsay (Ont.) plant, this was constructed by J. Howard Bridge as an experiment. He had had no previous experience in the construction of a municipal ozone water purification plant. The Baltimore plant was also constructed under Mr. Bridge's ideas; and neither the Lindsay nor the Baltimore plant are in any particular respect similar to the Ann Arbor plant. Both the Lindsay and the Baltimore plants have proved to be complete and total failures.
>
> The Bridge system depends upon a suction action of water passing through aspirators to introduce the ozone into the water. This means that from 3 to 4 cu.ft. of water must pass over the aspirator in order to draw 1 cu.ft. of water, which contains less than one gram of ozone per cubic meter of air. This concentration is entirely too low to perform the work of sterilization.
>
> In the Ann Arbor system we compress the air and deliver it to our ozonizers under compression. It immediately becomes thereby compressed ozone. This is delivered under a pressure sufficient to overcome the head of water in the sterilizing towers, and tears the water into a white foam, at the same time passing into each tower through four baffle screens covered with about 9 in. of gravel. The ozone under this compression drives its way through the water passing the opposite direction through the gravel; the entire process being repeated four times in four separate towers, which means perfect contact and the destruction of all pathogenic bacteria.

The lengthy discussion on ozone, which we have outlined in brief, was brought to a close by remarks and a motion by J. C. Martin, of Wilmington, Ohio, which resulted in the authorization by the meeting of the appointment of "a committee of disinterested parties" to examine and report on the Ann Arbor plant, the report to be mailed to the members, or incorporated in the 1912 or the 1913 Proceedings. In answer to a question, Mr. Martin said his idea was to have the chair appoint the committee, choosing "such men as professors from Ann Arbor College [University of Michigan] or experts from the Michigan State Board of Health, or men whose reputation and position both for honesty, integrity and ability will carry force with the report—not merely selected from our membership." After this explanation the motion was adopted.

A paper on "The Purchase of Lime for Water Purification," by W. F. Montfort, of St. Louis, Mo., which was read by title and ordered printed, reviewed that subject in considerable technical and economic detail. Summing up, the author stated that purchase guarantees should be based on a single percentage; that fines and penalty clauses against impurities should be in terms of percentage of contract price, and that methods of sampling and analysis should be described in the specifications.

Hollow Reinforced - concrete Poles, piles, pipe and columns are manufactured by a novel process recently devised by R. M. Jones, of Denver, Colo. The novelty of the process lies in the formation of the piles and other members without forms, between a belt passing over two compression rolls. These two rolls are mounted on separate shafts, a sufficient distance apart so that the right-sized member can be placed between them, and a belt weighted at either two ends, and of a length equal to the length of the member desired, is passed over the two rolls and allowed to sag between them to the level of two idler rolls beneath.

In the work of manufacturing the pile or pipe an interior mandrel is placed on the belt and allowed to carry by its own weight the belt to the lower idler rolls and the reinforcement is held the correct distance away from this mandrel. The rolls are then started and the concrete, fairly dry, poured down one side of the mandrel. This is pulled by the action of the belt around the mandrel until it forms a complete circumferential covering and meanwhile the two main rolls are pushed closer together by pneumatic force and exert a compressive action upon the revolving piece. This compression causes a dense concrete. When the process is finished the belt is pulled up level and the pile or pipe with its interior mandrel in it is slid off onto a platform where it is allowed to remain for a short time and the interior mandrel removed.

Sewage Disposal by Oxidation*

Views of a British Designing and Operating Engineer

By John Duncan Watson†

By John D. Watson, Gilbert J. Fowler, Robert S. Weston, Geo. A. Soper, F. H. Bass and L. L. Tribus

Oxidation is here made to cover nearly the whole range of current methods of sewage treatment, but more particularly percolating or sprinkling filters, contact beds, intermittent sand filters and disposal by dilution.

*Abstracts of papers and discussion before the International Congress on Hygiene and Demography, Washington, D. C., September, 1912. The paper by Mr. Watson has been but slightly condensed from a copy supplied to this journal by him. The papers by Messrs. Fowler and Weston are presented only in their most salient features, as noted while they were being read. The paper by Mr. Soper is presented in official abstract, as printed for distribution at the Congress. The first three papers were read before the section on State and Municipal Hygiene. The fourth, before the section on Hygiene of Traffic and Transportation. In a later issue we shall reprint a paper on "Sludge Disposal," by Karl Imhoff, of Essen, Germany, read before the section on State and Municipal Hygiene.

In using the words "sewage disposal," sanitary engineers have more in their minds than merely conveying an objectionable liquid beyond the reach of the masses, and when they speak of "purification of sewage" they think of something less than a complete elimination of those substances from potable water, which, when added to it, gives the liquid the designation of sewage. Complete elimination is prohibitive, inasmuch as it is beyond the limits of a reasonable rate on the public purse. The word "purification" as it is employed in this paper should not absorb oxygen from the stream restricted sense.

Standards—There must, of course, be some standard to guide the designer of a sewage-purification plant, but what that something should be, it is difficult to say. A standard should be more or less of a movable quantity, high where the river into which the effluent to be discharged is pure, and not so high where the river is impure and of great volume.

On the whole the condition of the river below the point where the effluent joins it is a safe guide, and should be the ruling factor in determining the degree of purification desirable. I suggest that the designer of the plant should aim at producing, (1) a sewage effluent that will not putrefy on being kept for seven days at a uniform temperature of 80° F.; (2) that it should be the result of natural processes; (3) that it should not contain more than 3 parts per 100,000 of suspended solid matter, and (4) that it should not absorb oxygen from the stream into which it flows.

Preliminary Sedimentation—In purifying sewage by oxidizing methods it is essential first to separate the solid from the liquid impurities, not because it is impossible without nuisance to purify crude sewage on oxidizing beds, but because such a course is far from economical. The sludge question is to be introduced by Dr. Imhoff. It is, therefore, unnecessary here to discuss it, beyond emphasizing its importance in every scheme of purification. The success of every oxidizing process is more or less dependent upon the efficiency of the methods adopted to eliminate solids. The most perfect design of oxidizing filters may be rendered abortive if the sewage is not suitably prepared before it is applied to the surface of the medium.

The evolution of the Emscher tank has given a fillip to the consideration of the sludge question, which will bring us nearer the solution of the sludge problem. Care should be taken, however, not to clothe the tank with virtues which it does not pretend to possess. It has been designed to retain and digest solids, and render them at once inoffensive and capable of being readily dried at moderate cost, and I can bear testimony to its ability to do all this, but it does not follow that the Emscher tank will be a suitable medium by itself for preparing sewage for the bacteria bed. It does not take the place of the settling tank, whose function is to equalize the quality of sewage arriving at the outfall works, nor does it pretend to eliminate colloidal or ferruginous matter, which, if run on to a filter in excessive quantity, would certainly impair its usefulness. The tank, however, has succeeded in keeping sewage from fermenting when that course is desirable, while the solid organic matter is at the same time resolved by the septic process into an inodorous and easily dried substance incapable of giving rise to nuisance. I tried hard to make this stride in 1901, but failed, after an effort extending over the whole year. In a paper read in 1906, at the annual conference of the Institution of Municipal and County Engineers, I stated that the irreducible residuum of the septic process was an inodorous substance which had been used at Birmingham since 1903 to fill up land depressions in the neighborhood of the septic tanks. Thanks to the excellent work of Dr. Travis and Dr. Imhoff this work has been still further developed.

When the sewage has been properly prepared by settlement chemical precipitation, septic action, or a combination of them all, it should be exposed to the action of the friendly microbe and if that action is sufficiently prolonged, the constituent matters of the sewage, such as albumen, are practically destroyed, or, more correctly, converted into carbonic acid, free ammonia and nitrates. When everything is taken into account, I believe it will be found that this can best be done on what are termed percolating filters, but contact beds are also capable of doing somewhat similar work, and if the production of a consistently good effluent were the only desideratum, land irrigation, and intermittent filtration, which is a form of the same thing, are capable of doing even better work.

One of the reasons assigned for the appointment of the Iddesleigh Commission in 1898 [Royal Commission of Sewage Disposal—Ed.] was the difficulty of obtaining suitable land in England for sewage purification. As everyone knows the Interim Report, issued by the Commission in 1903, stated that it is practicable to produce by artificial processes alone effluents which will not putrefy, and may be discharged into a stream without creating a nuisance.

Land Treatment—At no time has the efficiency of good land as a vehicle for sewage purification been impugned. When land has been found to be unsuitable in quality, inadequate in area, or too dear in price, it has been condemned. A notable instance of this is to be found at Birmingham where the District Drainage Board acquired five or six miles of the valley of the Tame at a cost of £400,000. Much of this land was unsuitable in quality, and the constant increase of population rendered it necessary to adopt other methods of purification, but so far this is the only example of a great sewage farm having been abandoned in favor of a biological purification plant. There appears to be a prospect of Paris following the same course. A paragraph on page 92, Vol. 2, of the Report of Dr. Calmette and four colleagues to the Minister of Public Instruction [France], after describing what Birmingham has done, says: "This is exactly the solution which we are convinced will be forced on the city of Paris."

Contact Beds—Some years ago a well known English expert, in speaking of the relative merits of percolation and contact beds, stated that contact beds were dead. His remark was somewhat premature as Sheffield has since laid down 40 acres of those beds; at the same time he voiced an opinion which is being strengthened daily, and it may now be assumed that percolation beds are being constructed in England in prefer-

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ence to contact beds wherever the conditions are suitable. A notable case to the contrary is Oldbury, where a series of experiments extending over a considerable time, led Professor Frankland and Mr. Silvester to the conclusion that triple-contact beds were more suitable than percolating beds for the purification of a sewage containing large quantities of acid of which sulpho-cyanide formed a prominent feature.

PERCOLATING FILTERS—In their Fifth Report the Royal Commission state that taking into account the gradual loss of capacity of contact beds, a cubic yard of material arranged in the form of a percolating filter will generally treat satisfactorily nearly twice as much tank liquor as a cubic yard of material in a contact bed. Percolation filters are better adapted to variations of flow than contact beds. The effluents from them are usually much better aërated than the effluents from contact beds, and apart from suspended solids, are of a more uniform character. The risk of nuisance from smell is greater from percolating beds than from contact beds. The Commission also found that with percolating filters there is nuisance from flies. No one has attempted to upset the *dictum* of the Commission, and where contact beds are adopted in future there will probably be found to exist special local and physical reasons for their preference.

The cardinal principle which has always influenced me in preferring percolation beds to contact beds is the belief that the oxidizing process is dependent upon the free admission of air into the heart of a bed. It is obvious that the air supplied to this form of purifying agency is restricted to the volume of sewage treated, whereas it may be equal to many times that volume in a well constructed percolation filter.

That we have succeeded in constructing the best possible filter should not be taken for granted lest progress be unduly fettered, but whatever advance the future may bring with it, the percolation bed as we now know it is not likely to be improved out of recognition.

RECENT BIRMINGHAM PERCOLATING FILTER UNIT—A brief description of the percolating filter most recently constructed on the Birmingham Works may be taken as an indication of what I consider an oxidizing bed should be for the treatment of strong sewage. The filter area referred to is 6.6 acres, and it is nearly equally divided into two portions. The floor is laid with concrete, 4 in. thick, on a foundation inclined at a gradient of 1 in 100 toward the effluent channels. The concrete floor is covered with semicircular aërating tiles. These are carried through the inclosing walls, so that the air may pass without hindrance from side to side of the bed. The inclosing walls are 5 ft. in height, and are built of rubble stone (Croft granite) laid without mortar. The thickness of the base is 30 in., battering 5 to 1 on the outside face, and where the walls are built transversely to the lines of aërating tiles the latter are carefully bedded and leveled on top with cement mortar to form a foundation for the wall. The top course is leveled up with stone bedded in cement mortar. The medium, which has an effective depth of 6 ft., consists of hard stone or ball slag of best quality, broken as uniformly as possible to pass a 2-in. ring and be rejected by a 1-in. ring. The main supply pipe, 21 in. in diameter, is laid alongside the eastern walls of the block, from which branch pipes, 10 in. in diameter, are led to the beds and extended to the opposite side, where they are connected up to the wash-out pipe. These branch pipes are laid across the beds in parallel lines, and at right angles to them 3-in. distributing pipes are laid, in which spray-jets are inserted. The pipes are made of cast iron and weigh 6½ lb. per ft.; the thickness is not more than ⅜ in., since the maximum head is only 10 or 12 ft. They are laid on the bacteria bed without special support, but Jones' expansion joints have been employed to couple them together.

The actual cost of constructing Block D, exclusive of any work or pipe connections beyond 3 ft. outside the walls, is as follows:

Excavation	£1,100
Concrete floor	2,250
Collecting channels	200
Tile floor	4,500
Rubble walls	850
Medium	19,860
Distributing pipes	1,650
Valves	175
Total	£30,585

On a net area of 6.6 acres this is equivalent to £4620 per acre.

FILTER MEDIUM—Purification depends on various factors, but mainly upon the extent of bacterial surface—as Mr. Rudolph Hering has called it—over which the tank liquor is made to trickle and the time it occupies in percolating from top to bottom. The question of the size of medium and depth of bed must have a direct bearing up n the volume and strength of liquor to be oxidized.

Theoretically a fine medium should be preferred to a coarse one. Dr. Reid has studied the virtues of small medium and as the result of his study and experience he has consistently advocated its use. He can point to Hanley and other places where fine medium is used successfully; he can show that there is eight times the bacterial surface available for purification in ¼-in. cubes as compared with 2-in. cubes, and he can show consistently good effluents from fine-grain shallow filters. The Dorking experiments confirmed the main points of Dr. Reid's contention. At Birmingham and other places medium of a large size, approximating to 2-in. cubes, is used.

Since it is admitted that with fine-grain medium less depth is required, and a more brilliant effluent obtained, the question naturally arises, why not adopt fine medium? Chiefly because large medium of greater depth to do the same work is not more costly, and it provides greater security against pooling and clogging.

In large manufacturing districts sewage varies in composition, and an engineer in designing a purification plant should see that it is capable of giving that elasticity which is invariably demanded from purification plants in exceptional weather, and when unexpected rushes of trade waste arrive at the works.

The designer of oxidizing beds should not rely upon the infallibility of preliminary tank processes to free the filters of all unnecessary work. Mistakes take place in management, the composition of the sewage may permanently alter, and the colloids permanently increase, as at Manchester, where the albuminoid ammonia figure has in recent years gone up nearly 100%. A town's manufactures may change entirely, as at Coventry, where silks and watches have given place to the motor industry. Aëration is often impaired by unfavorable climatic conditions. For instance, at Birmingham, where unseptic sewage was applied to the bacteria beds in cold weather, it was found that the surface rapidly became "mackintoshed" over with a thick gelatinous fungoid growth. No doubt this is a condition capable of prevention, but the designer of the works may have no control over the management and should see that a sufficient margin of safety is secured by constructing a filter which readily recuperates, otherwise the design is unjustly blamed.

Anxiety on the part of public bodies to keep down initial expense in constructing bacteria beds should be met firmly and if possible with figures to prove that cheap beds are not profitable. A medical friend, who holds a distinguished public position, once complimented me on the appearance of the massive masonry walls round the Minworth bacteria beds, but proceeded to question whether the expense was justifiable, and added that medium should be allowed to slope on a natural angle from the top of the bed. He was astonished when I gave him figures to show that his untidy method would cost double what the massive walls had cost. Later, he suggested that the nitrifying organism would do as good work on a heap of unscreened clinker as on a well prepared oxidizing bed, and he pointed to a case where beds had cost less than £2000 per acre. I told him that I had constructed several acres of beds in this way at a cost of only £800 per acre. I was not able then, but I can now give the cost of treating 1,000,000 gal. [Imp.] of sewage on those "cheap"

beds compared with the cost of treatment on the beds already described:

	Slag and granite	Furnace ashes
Volume in million gallons	1,741	308
Capital cost per acre	*£7,100	£800
Interest on capital cost (5.6%) per million gallons	£1 10s. 3d.	18s. 11d.
Working cost per million gallons	1s. 4d.	9s. 9d.
Total cost per million gallons	£1 11s. 7d.	£1 8s. 8d.

*This figure includes a proportionate share of the cost of supply and effluent channels, silt and separating tanks, railway, wharf, etc.

The initial cost of the "dumped" furnace ashes bed, it will be observed, is low, and the maintenance charges high as compared with the carefully constructed stone and slag bed. The furnace ashes bed—as might be expected from 6 ft. of fine medium—produced a very good effluent, but the surface being dosed with strong Birmingham sewage clogs readily. Washing and replacing are not attempted, as this work would amount to ½d. per yard, or much more than new material would cost. Periodical scraping and removing the top layer is found to be sufficient.

It is urged against large medium that another process is necessary to separate the humus from the filtrate before it is fit to enter a river, but as this can be done in separating tanks for two shillings per million gallons, the objection is of comparatively small moment.

A fine medium bed had advantages where a brilliant effluent is a desideratum, where it would be difficult to get rid of humus from the filtrate, where a high cost for maintenance is not prohibitive, and where a temporary stoppage of the whole plant would not be a very serious matter, but it is not suitable for installations of any magnitude.

Unless where the upper layers of a percolating bed consists of very fine medium, as in Dr. Dunbar's filter at Harzburg, the sewage in its passage through a healthy filter emerges at the bottom immediately under where it drops upon the surface. The establishment of this fact emphasizes the desirability of feeding a percolating bed in such a way that each particle of material receives an equal quantity of liquor.

DISTRIBUTING APPARATUS — Engineers have had varying success in their efforts to design appliances capable of fulfilling this important condition. Some excellent devices have been brought to the notice of the public by their makers, and a good deal might be said in favor of each, but the best are costly, and the worst are cheap only in name. It may be assumed that moving distributors are all liable to be prejudicially affected by wind, frost, and snow, unless when they are power-driven, in which case they are more costly. On the other hand, wind, as it influences the spray jet—and it is rarely perfectly calm in this changeable climate of ours—tends to equalize the distribution when this type is used.

Absolute uniformity of distribution there cannot well be. Even the Scott-Moncrieff distributor, the most uniform distributor I have known, which rotated round Bed C at Minworth with all the regularity that an electric drive could give, dropping as it traveled sewage so equal in volume that test-trays 12 in. square placed close together in a straight line from center to circumference resulted in collecting the same quantity in each tray, was no exception to this rule.

My contention is that the total effluent must necessarily be compounded of volumes which have undergone varying degrees of purification on different parts of a filter. If for mechanical or meteorological reasons the spray is not distributed uniformly, certain portions of the filter get more work to do than others, but this is got over to a large extent by changing the position of the jets periodically and, of course, change in the direction of the wind constantly brings about minor changes automatically, which tend to even up the distribution. So long as these conditions obtain, and water-logging is avoided, the practical result is not unsatisfactory. Nor should it be forgotten, that even although the intermittency is irregular, that part of the bed which for the time receives no sewage may be recuperating and adjusting itself to bear a strain later on. Assuming for a moment the worst possible case—namely, that a certain portion of the filter never received any sewage, the effect would be that a larger volume of filtering material would be required to achieve the same result, and thus the true engineering aspect of the matter appeared, namely, the question whether it was better economically to spend money on extra filtering material, or on extravagant methods of obtaining ideal distribution. This could be decided only by considering the total resulting purification of a given volume of sewage, in terms of the total cost of obtaining it, and not merely the cost of the distributing mechanism.

All forms of distribution on percolating filters are liable to give rise to nuisance from smell, if a strongly smelling liquor has to be dealt with. In the case of trays or tipping troughs the smell is confined more or less to the immediate vicinity of the filter, and it may be largely done away with at small works by providing an inexpensive form of cover for the filter. The spray jet has been held to be the most liable to give rise to smell, but moving sprinklers are almost equally bad in this respect. This is bound to be more apparent during periods of prolonged heat, but the application of hypochlorite of sodium as used at Ostend in Belgium, or hypochlorite of calcium as used at Birmingham, Hanley, Burslem and Stratford-upon-Avon, although costly, is fairly effective when mixed with the tank liquor before its application to the oxidizing filters. Care should be taken not to apply as much as will inhibit the life of the nitrifying organisms, or produce injury to the river into which the effluent enters. If it is applied before septic action is too far advanced, 1 part per 100,000 will probably be found to be sufficient, and this quantity will be more than enough to keep down the fly nuisance.

MANAGEMENT—One word with regard to management. However well a plant may be designed, if it is not well and skilfully managed it will become a nuisance and bring discredit on the engineer who designed it. The disposal of the liquid filth of a great community has an enormous potentiality for evil, and if a town authority believes it necessary to avert this by expending large sums of money on constructional work, it is their bounden duty to see that the plant is placed in the most competent hands. Local authorities are by no means sufficiently alive to this aspect of the question, with the result that too many works are left to the management of untrained men. Hitherto anybody has been deemed good enough to look after a sewage works, but the day has now come when the manager should be a highly trained technical expert, if a local authority hopes to get full value out of the sensitive entity which we call a bacteria bed.

Summary of the Views of a British Chemist and Former Sewage Works Manager

BY GILBERT J. FOWLER*

Among the criteria resulting from a commonsense view of the sanitary and esthetic results which may reasonably be expected from sewage treatment in the light of experience are the following:

(1) An effluent should be produced which will not deteriorate the stream into which it is discharged. The effect of a small residue of organic matter upon the animal life in a stream is surprising. The experience with fish life in sewage effluents ponds in Bavaria is worthy of study.

(2) The proper division of sludge reduction between preliminary treatment and filter beds is also a worthy subject for study.

As to chemical treatment, it is doubtful whether this is advisable in America, where the water consumption is so heavy. Chemical treatment may be advisable where sludge disposal is cheap, land costly, filter construction expensive, and special trade effluents have to be dealt with.

Large tank capacities have value as equalizers. The solids retained by the Imhoff tank are such as settle in two hours. The fine and colloidal matters pass on with the effluent, thus increasing the work of the filters. To get the best

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results the Imhoff tank should be supplemented by some form of equalizing tank. A test Imhoff tank is to be built at one of the small sewage works of Manchester, England.

Slate beds are successful in dealing with sludge without a nuisance, but are costly.

(3) The kind of filter in favor in America, and largely so in England, is the deep percolating filter. However advantageous the percolating filter may be it does not meet all the requirements, and it is liable to give rise to odors and flies. No doubt the great advantage of contact beds lies in their freedom from nuisance. The large area of contact beds at Manchester, England, has given no trouble.

While in a general way sewage disposal is in a settled state, there still remains plenty of work to be done for years to come through the coöperation of the engineer, the biologist and the chemist.

Views of an American Engineer

By Robert Spurr Weston*

It is strange that so much more attention has been given to the final than to the preliminary treatment of sewage. Pretreatment effects economy in the operation of treatment works proper and increases the rates of the latter.

Sewage screens are in use at Reading, Penn., Brockton, Mass., and Atlanta, Ga. At Reading the results have been satisfactory from the screening viewpoint, but there have been mechanical difficulties and it is not certain that screening pays. The disposal of screenings is a problem. It seems unwise to have two kinds of sludge for disposal.

Regardless of sludge disposal, sedimentation is economical.

For sewage disposal by dilution not only should there be plenty of oxygen, but also an intimate mixture of the sewage with the diluting water, which may be difficult unless many outlets are provided. There should be 50% of oxygen in the mixed sewage and water; 70% may be insufficient where there is much sludge.

Contact filters seem to deserve more recognition in the United States. They have given good results at Mansfield, Ohio, and Plainfield, N. J., but there has been over-septicization of the applied sewage at the latter place.

Sprinkling filters, of which there are 12 to 15 in the United States, do not give so good results as sand filters. The flies which breed in them are not house flies and it has not yet been shown that they spread disease.

There are 60 to 70 sand filters in the United States, exclusive of hundreds at institutions. They give good results where proper filtering material is available, and are particularly valuable where high results are needed.

As bearing upon the degree of purification required, water purification should be relied upon to protect public water-supplies. The best way to judge the results of a sewage-treatment plant is to learn the effect of the effluent upon the water into which it is discharged.

In conclusion, first determine the degree of oxidation required, then choose the best method to accomplish this at the lowest cost, remembering that each problem is a rule unto itself.

*Consulting Sanitary Engineer, Boston, Mass.

The Disposal of Sewage into Tidal Waters

By George A. Soper*

No large cities have as yet given the subject of sewage disposal into tidal harbors the thorough study which will be necessary before the many biological and other questions concerned are fully understood. Because of the existence of many peculiar problems relating to health and the production of nuisance which are connected with the disposal of sewage into salt water, the knowledge which has been obtained in studying the effects of discharging sewage into land water cannot strictly be applied. Until a considerable mass of information has been collected by painstaking individual studies, each problem of sewage disposal for a seaport must be studied separately.

The City of New York affords an example of a great seaport which has been compelled to solve the problem of sewage disposal in a thorough and scientific manner. The capacious harbor, although possessing two main outlets to the sea, has become overburdened with the sewage of the immense population residing upon its shores. By the year 1940, the population, which is now about 7,000,000, will be doubled and the quantity of sewage will be correspondingly increased, while it is obvious that the water which will be available for the assimilation of these wastes will be no more than it is at the present time.

It will be necessary to make full use of the digestive capacity of the New York harbor water for sewage because of the large sums of money which it would be necessary to spend in order to dispose of the sewage on farm lands, by intensive purification or by pumping to the open ocean. The commission finds that this use can be made of the water without involving danger of nuisance or disease.

A prominent feature of the work of the Metropolitan Sewerage Commission has been a study of the part played by oxygen in the assimilation or digestion of sewage by tidal harbor waters. The researches described by the Royal Commission on Sewage Disposal of Great Britain in its Fifth Report have been applied and extended, these researches being materially facilitated by modifications made by the commission in the method of determining the amount of dissolved oxygen present in the water which permitted thousands of analyses to be made in open boats, sometimes in rough weather.

*President, Metropolitan Sewerage Commission of New York, New York City.

General Disscussion

Prof. F. H. Bass, of the University of Minnesota, Minneapolis, Minn., said that all over the United States there are septic tanks which have been neglected. In Minnesota some of these are nearly filled with sludge. He exhibited a blueprint showing how these might be converted into Imhoff [or near-Imhoff] tanks by building sludge chambers of greater depths than the tanks, either at the sides or as wells in the bottom.

L. L. Tribus, Commissioner of Public Works, Borough of Richmond, New York City, said his borough is conducting sewage-treatment experiments and invited suggestions. The problem is not how much purification can be achieved but how little can be got along with and still keep free from nuisance.

A lock-jointed spiral pipe now being put on the market has the special feature of a smooth interior surface, the continuous spiral seam or joint being made by interlocking the plate forming the pipe with a narrow outside strip, the seam thus serving as a reinforcing rib. The adjacent edges of the plate at each side of the joint are doubled back upon the body of the plate, and the edges of the outside strip are doubled inward so as to lap under the edges of the plate. The plate and the joint strip are rolled down under high pressure in a machine designed for the purpose, so that the joint is close and watertight. The plates for the pipe are cut to the required width from long sheets of soft open-hearth steel, their ends being then welded together to form continuous sheets or plates which are wound upon spools. The outside strip or band for the joint comes from the mills in long lengths wound upon spools. The two pieces are fed together into the machine, which produces the completed pipe. The width of the band is sufficient to give ample contact surfaces. In a bursting test made at Armour Institute, Chicago, the test piece was an 18-in. pipe of No. 20 galvanized iron, the length of the pipe between flanges being 6½ ft. A pressure of 235 lb. per sq. in. was required to burst the joint, the outside band bulging, but (as we are informed) the seam was not opened or fractured. The pipe can be made in lengths up to 20 ft. for galvanized and 25 ft. for asphalted pipe. The joints between the pipes may be telescopic slip joints, slip sleeve joints (with an inside sleeve and outside lugs wired together), bolted flanged sleeves, or steel flanges welded to the pipes and bolted together. This form of pipe is being introduced by the Standard Spiral Pipe Works, 25 N. Dearborn St., Chicago, and patents have been applied for covering the machines for its manufacture.

Letters to the Editor

Setting Poles with a Flat Car Derrick on a Western Massachusetts Interurban Electric Railway

Sir—The Western Massachusetts Construction Co. is building an extension of the electric-railway system in the Berkshires from Lee, Mass., to Hudson. The line is being made of first-class construction throughout, with maximum grades of 3% and maximum curves 5°. There is some heavy rock work in the cut and the excavated material has been used to fill several bogs along the line. The roadbed is 18 ft. wide on fills and 20 ft. wide in cuts. Over or under crossings are made at all highway intersections. Reinforced-concrete arches on the Luten system have been used for a number of these crossings, in several cases on concrete-pile foundations. The standard culvert is of the reinforced-concrete box type. The superelevation on curves is computed for a maximum speed of 50 miles per hour. The poles along the line, carrying the transmission wires and the trolley-wire brackets, are of chestnut 50 ft. in length, set 7 ft. in the ground. The holes for the poles are dug 3 ft. in diameter and filled with gravel and stone. For setting these poles a special derrick was built and mounted on a flat car. The cross arms with their pins are attached to the pole before erection. Thus the poles are put in place ready for stringing the wires without the use of linemen at all.

F. B. L.

Lee, Mass., Sept. 20, 1912.

Automobile Speed and Highway Location

Sir—The editorial on "Automobile Speed and Highway Location," in your last issue, leads me to call attention to some interesting statements made in the new "Highway Engineer's Pocket Book," by Harger and Bonney, bearing upon some of the points in your article.

According to their view, the width and alignment of a highway on a curve should depend upon the "safe sight distance"—the latter depending upon the speed of the automobile and the location of the curve. The degree of a curve in a given case should be such that the driver of a car traveling at the rate of 20 to 30 miles an hour should be able to see far enough ahead to turn out and pass a car approaching in the opposite direction without applying the brakes. As a result of numerous letters sent to the various automobile clubs of the country, the users of automobiles seem to agree in the main upon distances of 250 to 300 ft. for speeds of 20 and 25 mi. per hr.

The authors thus quote George C. Diehl, Chairman of the Good Roads Board, Automobile Association of America, and County Engineer of Erie County,

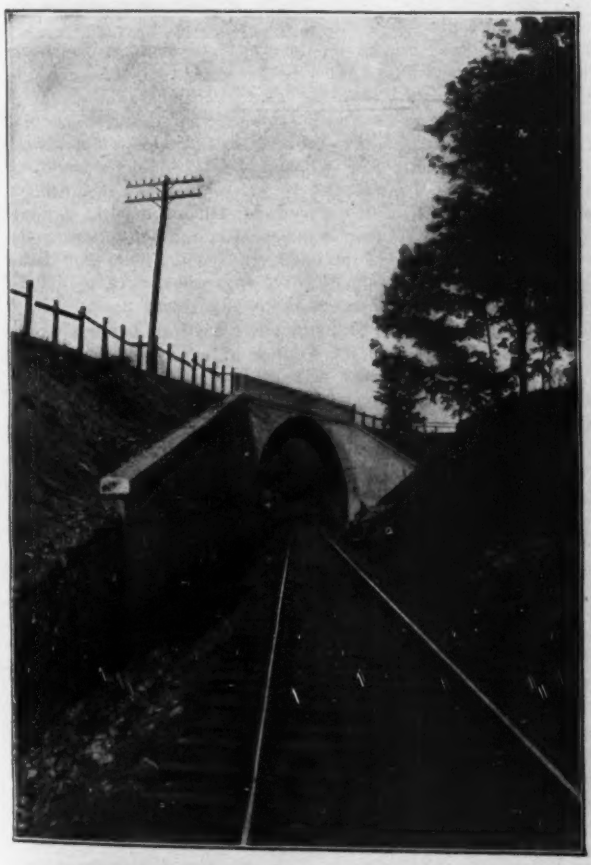

FIG. 1. A CONCRETE ARCH, BUILT ON A SHARP SKEW

FIG. 2. A FLAT CAR DERRICK FOR SETTING POLES ALONG AN INTERURBAN RAILWAY

N. Y., in reference to emergency stops and passing without slowing up:

> The tests that we have conducted show that a car going at the rate of 20 miles per hour can be stopped at 40 ft., and one going at 40 miles per hour can be stopped at 140 ft. with the emergency brake. For passing a rig going in the opposite direction this distance would not be necessary.

The authors state that the minimum sight distance in use in New York State is from 250 to 300 ft. They give a table showing the sight distances for different degree curves on two different bases, one where the line of sight is 6 ft. from the ground (which they claim is about right on a straight grade for a road in a cut 22 ft. wide with side slopes of 1 on 1.5) and another assuming the line of sight close to the ground, as occurs in rounding the top of a hill. According to their tables a 50° curve, radius 114.6 ft., would give 130 ft. sight distance in the first case and only 100 ft. in the second. To follow the above New York rule would require the use of no curve sharper than a 12° in the first case nor than an 8° in the second case, having radii of 477.5 and 716.3 ft., respectively. The safety of modern methods of travel, when, as shown by the recent census taken in Massachusetts, on many roads from 85% to 95% of the vehicles are automobiles, certainly demands of the present-day highway engineer a very careful consideration of this subject.

JOHN V. HAZEN.

Dept. of Engineering and Graphics,
Dartmouth College, Hanover, N. H.,
Sept. 29, 1912.

Standard Tests of the Efficiency of Sewage Treatment

Sir—Mr. Hoover, of the Columbus Sewage Works, has done good service in presenting the need for standard tests of sewage purification in the ENGINEERING NEWS for Sept. 5. On every hand, well designed sewage-disposal works are being ruined and discredited by careless operation, and there is no more important thing to be done for the whole art of sewage disposal than to secure efficient control of the operation of these plants. This can only be done at present by the activity of the state authorities, for municipal authorities can rarely be made to take an intelligent interest in this matter. In order, however, that the state health department should take the matter up effectively, it is necessary that a much better agreement should be reached among analysts and sanitarians as to what constitutes a good effluent. My own view, in the light of present knowledge, is that methylene blue is in general by far the most satisfactory test at our disposal when combined with determinations of suspended solids. The ordinary chemical analysis is of little value, as Mr. Hoover points out, and the more elaborate oxygen tests are too complex for routine use. When the methylene-blue test is applied so as to take into account the time factor in the reaction, as suggested by Prof. Phelps, it is of the greatest value.

I cannot, however, believe that it would be wise to form a new organization for the purpose of dealing with this subject. We now have in the American Public Health Association a thoroughly representative body which stands for public health in all its branches. A joint committee from its laboratory section and its sanitary engineering section should be admirably fitted to deal with the formulation of such standards as Mr. Hoover has in mind.

C.-E. A. WINSLOW.

Biological Laboratories, College of the City of New York, Sept. 17, 1912.

Sir—The article by C. B. Hoover on "Standard Tests of the Efficiency of Sewage Treatment," which was published in ENGINEERING NEWS of Sept. 5, suggests a few points which may be worthy of emphasis.

Table I indicates a marked lack of uniformity as to the tests used at different places and shows clearly that plant control requires fewer tests than are necessary for obtaining the data required in testing-station work prior to design. It is, of course, apparent that if a sewage-disposal problem is important enough to demand experimental study, many more complete analytical data are required than for operation control after purification works have been constructed. In standardizing tests, therefore, it would seem wise to classify such tests with respect to (a) Operating Control of Testing Stations, (b) Operating Control of Sewage Purification Works. It would further seem desirable to subhead plant control with respect to (1) Plants which are intended to effect non-putrescibility by modifying the organic matters, i.e., Sprinkling Filters and Contact Filters; (2) Plants which effect a most thorough removal of the organic matters by mineralization, i.e., Sand Filters.

In other words, the coarse-grained sewage filter requires different control than the older sand filter. This point appears worthy of consideration when there shall be undertaken test standardization for sewage and sewage effluents. Mr. Hoover's discussion suggests the thought that while much method standardization work is needed, the standardization of the tests themselves should not be neglected.

Confining the discussion to plant control for works designed to effect the stability of the final effluent, it is instructive to inquire what are the practical conditions the plant may be expected to fulfil as regards stream protection. Let it be assumed that the reason for constructing the works was a need for abating a localized sewage nuisance; or in other words a condition where the permissable limits of dilution disposal had been exceeded. That principle to which the design is so intimately related and with special reference to which the plant is operated, is that the existence of the sewage-purification works shall be the means of restoring the stream to the condition which existed before the introduction of a system of water-carried sewage into the community in question.

In view of the above, all tests which throw light upon the oxygen relations of the effluent are of chief importance. Developments along this line have been most rapid in the past few years and it is in respect to stability and putrescibility tests that it is believed tests standardization should be sought.

In the recently issued report of Mr. Hoover covering the work of the Columbus sewage purification works for the year 1911, on pp. 25-26, there are presented data regarding River Inspection. Such data seem of special value not only as regards the operating control of the Columbus plant, but also with respect to the operation of any other plant where nuisance prevention is the object sought. In many investigations of sewage-purification plants and at many plants the practical side seems to have given place to the theoretical. Too much emphasis appears to have been placed upon the character of the effluent as regards its stability *per se*. That is, there are few data available to indicate in a practical way whether local conditions could be satisfied by a less thorough modification of the sewage effluent organic matters than is indicated by the non-putrescibility of the undiluted effluent. More consideration of River Inspection, such as undertaken at Columbus, seems desirable.

Dilution plays such an important part in the solution of sewage-disposal problems that the necessity for continuous river inspection at practical plants seems most desirable. Many data are available regarding the dilution disposal of crude sewage, many less respecting the effect of preparatory treatment prior to dilution disposal and still less as regards the disposal by dilution of coarse-grained filter effluents the organic matters in which are but partially modified to stable humus. Full data regarding the dilution disposal of sewage and sewage effluents of different types in salt water, and in fresh water, moving and still, would go far toward assisting in the solution of the problem as to whether it is necessary to construct special plants for furnishing oxygen to the unstable organic matters of sewage or whether the necessary oxygen may be supplied through Nature's unaided channels.

A. ELLIOTT KIMBERLY,
Sanitary Engineer,
Columbus, Ohio, Sept. 28, 1912.

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Sworn to and subscribed before me this 30th day of September, 1912.

Wm. W. Mayer,
[Seal.] Notary Public
(My commission expires Mar. 30, 1913)

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*Illustrated.

Enthusiastic Americans who saw a second Major L'Enfant in Walter Burley Griffin, the Chicago architect who was awarded the first prize in the Australian capital city competition (ENG. NEWS, July 4, 1912, p. 41) are likely to be disappointed. At present it looks very much as though Mr. Griffin will have to content himself with the $8500 that his prize design brought him and regretfully put by the higher satisfaction of seeing that design converted into the streets and buildings of a new metropolis. Although the Australian Government in advertising the competition made no promise of using exclusively the prize-winning plan, the general custom of such competitions would lead to the belief that those plans not premiated would not be utilized in any way and that the prize winners would have some part in the execution of the adopted plan. A recent letter from an Australian official who was intimately concerned with the award makes it evident that this custom is to be disregarded.

Among other things, this letter says:

I doubt if any of the designs will materialize as a city, since the responsible minister has appointed a departmental board to evolve an "official design" based upon the premiated designs and conceived in the light of the ideas and data disclosed by the plans of the unsuccessful competitors also, of which copy has been made. The proposition is unjust to those who have competed in good faith. The whole matter is involved in official and political intrigue.

Mr. Griffin has at least his £1750. In this he is several pounds ahead of his distinguished predecessor, the designer of Washington City.

Another Crossover Derailment on the New York, New Haven & Hartford R. R.

The fatal railroad wreck near Westport, Conn., last week calls renewed attention to the danger which may lurk in an abrupt crossover switch, as well as the danger of running trains at excessive speed in order to make up time. Of course, it may easily be that the estimates of the train speed are excessive, which were made by those who saw it rush past the station and overturn at the crossover. There can be no doubt, however, that the train was running at far too high a speed to take the crossover safely, and it is universal practice on the New Haven, as well as on every other railroad, for an engineer to attempt to make up time when his train falls behind the schedule.

As we recently noted in these columns, the Pennsylvania R.R. has issued orders limiting the maximum speed which may be made when an engineer is trying to make up time to 70 miles per hour. This is a step in the right direction, yet it furnishes no guarantee that an engine runner may not maintain too high speed over a crossover or a very sharp curve.

After these two successive bad wrecks on the New Haven road, following each other within little more than a year, each of them due to a derailment caused by taking a crossover at too high speed, it would seem likely that crossover switches of easier angle would be adopted on that road in main-line track, as is the

practice already on some other railways running high-speed trains.

Of course, it will be agreed that the ultimate cause of the disaster was the engine runner's failure to obey the signals which warned him to slacken speed; and the problem is brought up anew to the railway world what, if anything, can be done to insure better obedience to fixed signals? To solve the problem of any mechanical appliance as a substitute for the engineer, on the automatic stop principle, seems to be a practical impossibility, because what is desired is not to stop the train entirely, as is the case in approaching a home signal at danger, but to check its speed sufficiently so that it may pass the curve with safety.

The problem of insuring the checking of speed at slow points is a serious one, not only in this country, but abroad. In England several of the worst railway accidents of recent years have been due to excessive speed over sharp curves, where the runner of a high-speed train failed to slow down sufficiently. Many will recall the disastrous wreck a few years ago to a fast express train from one of the channel ports to London, in which a number of prominent Americans, who had just landed from the steamer, lost their lives. There have been other accidents of this sort in England in recent years, almost equally serious.

It must be frankly admitted that in part at least such accidents as these are one of the inevitable penalties which we must pay for the privilege of high-speed travel. There is undoubtedly a reaction in railway circles from the craze for high speed which prevailed a few years ago, and we hear less frequently the fallacy that there is no more risk in running a train at high speed than at moderate speed.

But the adoption of moderate speeds does not settle the whole question by any means; and every engineer who has been responsible for railway repair work, making necessary the slow movement of trains over a given piece of track, knows what it is to suffer anxiety lest some careless engineer should fail to slow down sufficiently and thereby cause a wreck.

Another Leaky Dam Founded on Shale

In commenting last week on Mr. Hatton's apologia for the Austin Dam failure, we remarked upon the frequency of dam failures due to porous percolation through the underlying strata. In this connection a current investigation of a core-wall earth dam at Hornell, N. Y., is apropos. This dam, recently completed as part of a reservoir for an additional water supply, some weeks ago appeared not to be entirely water-tight, though available reports did not disclose the nature of the leakage. Somewhat later Alex. Rice McKim, inspecting engineer with the New York State Conservation Commission, has looked over the structure and, according to press reports, has come to the following conclusions:

> I find that the core wall was placed upon a laminated clay foundation into which it was sunk about 10 ft. at the deepest place. This shale rock foundation is evidently filled with fissures and should have been examined by borings for such fissures, and if any such were found, filled with grout under pressure. I understand that no such examination was made of the foundation. Had we [the N. Y. State Conservation Commission] inspected the work earlier we should have insisted upon such an examination of the rock on which the core wall rests.
>
> The present leaks are in all probabilities through such fissures in the foundation bed at the sides of the dam and under the core wall, as natural earth embankments are very porous. At present there is no need of any great apprehension to be felt on that account, as they are being very carefully looked after by the engineer in charge, who has instructed weirs to be built to gage the flow of seeping waters. He is also about to try to stop the leaks by means of clay deposited on the upstream side of the dam, hoping by this method that the seepage will gradually decrease, and if so, that there need be no apprehension on their account. This method has been tried in similar cases with success, and it is hoped that it will be effective in this case.

Ohio River Dam No. 26, the Austin Dam, and the Hornell Dam all should make engineers wary of the shale foundation.

A Protest Against Ugly Bridges

A renewed plea for attention to æsthetic considerations in bridge design is made by the Boston *Herald*. Commenting on two recently completed bridges over the Cape Cod Canal, it says:

> By general consent, each one disfigures its district. The bridge at Bourne, carrying the highway, may not have been designed piecemeal in hostile offices; but its appearance favors that hypothesis. The railroad drawbridge at Buzzard's Bay neither harmonizes with anything in sight nor pleases by its own design. What the noise and the smoke of the canal dredgers have been to quiet-seeking visitors in these recent weeks, that, for many years to come, the silhouettes of these ill-considered bridges will be to the beauty-loving traveler and resident.

We are not familiar with the particular bridges referred to; but the indictment drawn will fit a very large proportion of the steel-bridge structures erected in the United States. The engineering profession need not be unduly blamed for this, for the public demand has been almost invariably for cheap bridges rather than good bridges. The engineer has had task enough generally to secure a safe and substantial structure with the funds available, without spending anything to make his bridge beautiful.

There is now, however, a rapidly growing public demand that attention be paid to the æsthetic side in bridge design. One reason for the rapid growth in popularity of concrete bridges is that the material adapts itself so readily to pleasing architectural effects, if handled with even moderate skill.

Continuing, the *Herald* says:

> Americans, in and about the larger cities, have come to see what Paris, Florence and Venice saw long ago; the singular picturesqueness of a good bridge. Here at Boston, the parkway culverts, great and small, the echoing arch at Newton, above all, Mr. Wheelwright's bridge across the Charles, demonstrate the pictorial value of these structures when made beautiful by refining their adaptations.
>
> An ugly bridge is an injury to the public; by defacing the landscape, it wrongs the people at large to whom the landscape belongs. In many matters involving the public's rights, Massachusetts has already set her sister states a good example. The Commonwealth could wisely take another forward step by directing that designs for important bridges, whether intended for railroad or highway, should obtain approval from the State Art Commission.

Arbitration of Contract Disputes

Disputes between engineers and contractors over the purpose and intent of provisions of contracts and specifications are a frequent source of trouble in engineering construction work, and still further trouble is caused when the engineer is made (under the contract) the authority to settle such disputes. The anomalous position of the engineer as a party to a dispute and sole arbitrator of the same dispute is evident; but while the matter has been discussed from many points of view, nevertheless it is still general practice to put the engineer in this position. In a scholarly address on "Arbitration," delivered recently before the Western Society of Engineers by Onward Bates (Past President of the American Society of Civil Engineers), the advantages of properly applying the principles of arbitration to such disputes were set forth very clearly. Under such a system, both parties to the contract or the dispute have equal standing and representation in the consideration and settlement of the dispute.

The adoption of such a system of settling disputes in construction work would effect an improvement in another direction, namely, the more careful preparation of contracts and specifications. As remarked by T. L. Condron in the discussion, if the engineer realizes that any disputes or differences over contract and specifications will be submitted to a disinterested umpire or to arbitration, he will be all the more careful to so write them that a settlement of such differences will not be likely to reflect unfavorably upon him. And in saying this, we may

point out that it is not necessary to imply that without this system the engineer would be careless as to his contracts and specifications. It means simply that he would be more than ordinarily careful under this system. Furthermore, and this is of great importance, the very fact that the engineer would take such special care in preparation, would tend very largely to reduce and eliminate grounds or chances for dispute.

It is of interest to note also that the arbitration of disputes has been embodied in a uniform building contract adopted in Chicago (in 1911) by a committee representing the American Institute of Architects (Chicago chapter), the Chicago Architects Business Association, the Western Society of Engineers, and several local associations of contractors and manufacturers in the building industry. The contract provides that in disputes between the owner and contractor a decision is to be made by the architect, but if either party dissents from this decision the matter must be submitted to a board composed of three arbitrators. There are to be two arbitrators representing the owner and contractor, respectively, but an unusual feature is that the third arbitrator is to be selected before the contract is signed and is to be named in the contract. While this relates to building construction work, it would be an easy matter to adapt it to general engineering work.

How to Build Good Roads

The opinions of engineers may differ as to the best methods of building good roads or the most desirable materials to use in their construction, but there is one desirable feature of good-road construction on which all engineers will agree. There will be universal assent, we are sure, to the proposition that in order to build good roads successfully you must keep the work out of politics.

The State of New York is just now furnishing a very convincing object lesson as to the way not to build good roads. The amount of money which is being spent on road construction by that State far exceeds that devoted to this purpose by any other State of the Union. Originally the road work was placed in charge of the State Engineer. In New York the State Engineer is elected by popular vote and there is a change in the office, therefore, at least as often as there is a change in the political party in power. The State road construction went through various vicissitudes as a result of this frequent change of managers, and it came to be recognized by sensible men of all parties that the only way by which the State could build good roads economically and well was to create a permanent organization for road work by putting the work in charge of a nonpartisan commission.

Such a commission was created by an act passed in Governor Hughes' administration and there seemed a good prospect that the state might then organize and carry on its work of road construction and maintenance in the same systematic manner that the work would be done by a private business concern.

There came, however, a change in the political party in power and a new law was passed, wiping out the nonpartisan commission in charge of highway construction and reëstablishing the old system by which the road-construction force was liable to change with every change in the State's political complexion.

Let it be clearly understood that we hold no brief for the former non-partisan commission or the work which it did. Neither are we to be understood as criticizing the methods or the men under which the present New York State administration has conducted its highway work. What we maintain—and in this we believe engineers in general will agree with us—is that the *system* is wrong.

It was for that reason, and to defend the engineers who were, we believe, unfairly criticized, that we opposed the change in the system of control of New York's road work which was made two years ago. The present situation fully justifies, we believe, the position we then took. The New York *World*, with its wide circulation and influence, is publishing broadsides attacking the present highway administration in New York and alleging favoritism, corruption and graft on a huge scale. It is probable that the charges are greatly exaggerated, and until they are fully proved we prefer to believe that those responsible for New York State road work under the present administration have made an honest attempt, to the best of their ability, to carry out the law and build roads as economically and well as circumstances permitted.

The point we wish to emphasize is that so long as engineers and their work are under political control, such wholesale criticism is to be expected. The "outs" are certain to bring all sorts of charges against the "ins" at every new campaign season. Professional politicians are used to this sort of thing and have become hardened to it, but it gets under the skin of most honest and high-minded engineers. The best class of engineers, in fact, will not engage in work in which their reputations are always at risk, the tenure of their position is subject to the uncertain vicissitudes of political change every two or three years, and in which they get the credit in the public mind of being grafters, no matter how honest and upright their professional work.

Moreover, every student of public affairs knows that the first essential of success in governmental business, as in other business, is that responsibility shall be concentrated, so that the public shall know on whom to lay the blame if results are not satisfactory. No one will deny the soundness of this principle, but how can you place the responsibility for the construction of roads when that responsibility is changed every two or three years. Suppose a road goes to pieces and betrays bad workmanship and poor materials; it is very likely it will transpire that the engineers of one party drew the specifications and let the contract, and the engineers of another party carried the job to completion.

It seems an appropriate time to reiterate the stand which ENGINEERING NEWS has often taken with reference to the construction of public works of all classes; to wit, that their execution should be placed in the hands of an appointed commission of high-class men, and not subject to change with the vicissitudes of politics. We could point to a long list of important public works carried out by states and cities and by the federal government itself where this plan has been followed with marked success. Of course, we do not claim that this plan of organization can infallibly produce success, for no matter what plan is chosen, success will depend on the men selected to execute it. There are possibilities, we admit, too, of the members of a commission getting at loggerheads with each other and creating a deadlock. Notwithstanding all these possibilities, however, the fact remains that the greatest success in constructing great public works has generally been obtained by placing them under control of a commission. We may cite as examples the most important public works carried out in the State of Massachusetts during the past 30 years; and in New York, the works carried out by the New York Rapid Transit Commission and the Catskill Water Supply Commission. It is doubtless the success attained by the New York Rapid Transit Commission, as much as anything, that laid the foundation for the creation of the New York Public Service Commissions. These bodies have given the public another illustration of a permanent organization not subject to political vicissitudes and carrying on public work with a sole eye to efficiency.

The present turmoil over the road situation in New York illustrates, as did the Austin Dam failure of a year ago, the need of a permanent non-political engineering organization in every state to carry on the public work of that state.

Notwithstanding the current political agitation to secure the nomination and election of all public officers by direct vote of the people, we venture to say that the public at large will have much more confidence in a non-partisan permanent commission, appointed by a chief executive officer—Mayor, Governor or President—than they will in the bodies which they may elect themselves by the ordinary political machinery and which will be subject to change every year or two.

The Memphis City Club on the Newlands Bill for River Regulation by the Federal Government

We referred in our issue of Aug. 1 to the scheme, now being actively promoted, to commit the federal government to an expenditure of $50,000,000 per annum for flood prevention and river regulation, regardless of the engineering possibilities and impossibilities of the situation. As we then stated, the scheme is claimed to have received the formal approval of numerous Boards of Trade, Commercial Clubs and similar organizations.

It is worth noting that such "approval," as a rule, means very little. Meetings of such organizations are held but seldom, and when held for business purposes usually have only a few members present. The business of such organizations is generally transacted by two or three officers or by a small executive committee, to whose acts perfunctory approval may be given when a meeting is held.

Occasionally, however, it may happen that some member of such an organization may find action pending on some matter concerning which he is fully informed. Under such circumstances the indorsement or rejection of the project may have much larger significance. One such instance has been brought to our notice in connection with action taken by the City Club of Memphis, Tenn., respecting the bill introduced in Congress by Senator Newlands of Nevada to expend $50,000,000 upon so called "conservation" work.

This measure is being pushed before the public by Geo. H. Maxwell, and on May 18 he addressed the Memphis City Club upon it, following which the club adopted a resolution to print and distribute the address and ask the commercial bodies in Memphis to add their endorsement to the bill.

At this juncture the matter came to the attention of the club's standing committee on "Levees and Reclamation." This committee has prepared a report to the club on the Newlands Bill, which contains matters of such general interest that we print below the major part of it as follows:

C. C. Hanson, President City Club of Memphis,

Sir:—The question of flood protection and reclamation is the most vital question today, with which the entire Lower Mississippi Valley has to deal. The alluvial lands on both sides of the Mississippi must be protected from overflow, or the valley will begin a movement of retrogression, or at least cease to advance. The adoption by this club of the Maxwell resolution and the unqualified endorsement of the Newlands Bill would be substantially to say: "The levee system is a failure, we cannot depend upon it and are ready to grasp any vague hope that is held out to us of something better." We would virtually say to our representatives in Congress: "You do not know what you are doing in asking for specific Government appropriations for levees. Help Senator Newlands to pass his bill and we will be saved."

We ask the club not to handicap this Committee and our representatives in any such way. We recommend that the Club, in the light of the careful analysis of the Newlands Bill which we present below, should revoke the Maxwell Resolution and adopt as a substitute therefor the one which we herewith present.

The Newlands Bill provides that a Board of River Regulation be created, to be composed of the Chief of Engineers, U. S. A.; the Director of the U. S. Geological Survey; the Chief of the Bureau of Plant Industry; the Secretary of the Smithsonian Institution; one civil engineer; one sanitary engineer; and one hydro-electric engineer. This Board is to cooperate with states, muncipalities, counties, districts, corporations, persons, etc., in carrying out the purposes of the act, and is to pay more than half in such cooperation, to secure the highest development and utilization of the waterways and water resources of the United States.

The appropriation of 50 million dollars per year is to be divided as follows:

For building irrigation systems "to aid in the regulation of the flow of source streams or navigable rivers"	$10,000,000
For the forest service, for guarding against and fighting fires	4,000,000
For the protection, enlargement, etc. of water supplies by reforestation	1,000,000
For the Smithsonian Institution for study and dissemination of knowledge	1,000,000
For the Bureau of Plant Industry to maintain garden schools and instruction in irrigation	2,000,000
For the Geological Survey	3,000,000
For the acquisition of Forest Lands	5,000,000
For the Corps of Engineers, U. S. A., for use in building and maintaining of revetments, dikes, walls, levees, embankments, gates, wasteways, by-passes, floodwater canals, restraining dams, impounding basins, and bank protection works for river regulation, and, as a means to that end, the building of works for reclamation, drainage and flood protection, and for building reservoirs and artificial lakes and basins for the storage of flood waters to prevent and protect against floods and overflows, etc.	$24,000,000

You will note that 10 million dollars go to irrigation, 10 million dollars to forestry and 6 million dollars to surveys, the Smithsonian museum and a garden school.

The work to be done under this bill covers the whole area of the nation. How much of the remaining 24 million dollars will go to works which will tend to relieve us of overflows in the lower Mississippi valley? If it all went to building impounding reservoirs on the Mississippi tributaries, it would take 25 years to have available the $600,000,000 that it is estimated would be required to build enough reservoirs to relieve us from flood waters. If half of it should be expended in the entire Mississippi Valley, one fourth for reservoirs, and one fourth for levees and revetments, we would possibly, in 100 years, have an effectual reservoir system if enough suitable sites could be found. Meanwhile we wouldget the same sum annually for levees and revetment, that has now been appropriated by Congress.

Since the operation of the Newlands bill appropriation terminates in ten years, the reservoir would then be one-tenth built. Under this bill, however, it is contemplated that the Government will only pay one half the cost of any work. If the $600,000,000 is ever expended in building reservoirs, and if those with partnership interest must volunteer to pay $300,000,000 of it, it is a safe prediction that three fourths of the $600,000,000 will never be spent.

The reservoirs which might be built would doubtless be owned partly by water power companies, who would always keep the reservoirs as nearly full as possible, reducing to a minimum their available capacity to retain flood waters.

The subject which we are most interested in at the present time is the protection from overflows of the valley lands. The circulars and papers distributed hold out the alluring idea that this protection is to be furnished by levees supplemented by a system of comprehensive storage reservoirs in the headwaters of the tributaries of the Mississippi river.

This question of storage of water for the double purpose of preventing floods and assisting navigation was pretty well threshed out fourteen years ago in the investigations carried out by the Senate Committee on Commerce in the year following the disastrous flood of 1897.

Several hundred pages of printed testimony on the subject with maps, hydrographs, etc., may be found in Senate Rep. No. 1433, 55th Congress, Third Session.

The principal contributors were Prof. Willis L. Moore of the U. S. Weather Service, Mr. J. A. Ockerson of St. Louis, for twenty years previously employed on the Mississippi River surveys and studies under the Mississippi River Commission, Major T. G. Dabney, then, as now, Chief Engineer of the Yazoo-Mississippi (upper) levee board, Major William Starling, and some of the U. S. Engineers on the Upper Mississippi River improvements.

The testimony of these witnesses may be briefly summarized as follows: The engineers in charge of the Mississippi reservoirs claimed that navigation above Lake Pepin was improved for a small part of the year, but that no effect was discernible below that point. All available reservoir sites on the upper Mississippi of reasonable cost had been developed.

Major Dabney estimated that to protect from floods the lower central valley of the Mississippi it would be necessary to submerge an area equal to the State of Wisconsin.

Professor Moore testified that nothing happens west of Fort Smith, Ark., nor north of Keokuk, Iowa, to affect materially the flood conditions on the Lower Mississippi, on account of the extreme lightness of the rainfall. He told how the watersheds where the damaging rains actually occur had been searched all over for thirty years in the vain endeavor to locate any suitable place for the storage of flood waters. The only possible location he had to suggest was the upper portion of the St. Francis Basin.

Mr. Ockerson testified that to keep the discharge of the Mississippi river below one million cubic feet per second at Cairo, Ill. there would have to be diverted in all of the large floods sufficient water to cover 6000 square miles to a depth of 10 ft., or 11 cubic miles of water. He also suggested the St. Francis Basis for this, if it were to be taken up, 175 miles north and south by an average of 30 miles east and west. Since this area slopes, with a fall of 120 ft. in its length from north to south, cross divisions would be required to keep the water from all flowing out at the lower end of the basin. The spillways for passing the water down were estimated to require a width of five miles, with an average depth of 5 ft.

Well did the committee close the paragraph on "Reservoirs" in its report thus: "The scheme is regarded by nearly all committees and other experts as wholly impracticable. In short, your committee can discover no just or adequate relief in reservoirs."

In the Pittsburgh plan of reservoir construction, 17 reservoirs which are proposed for early construction, to afford partial relief to Pittsburgh flood conditions, are estimated to contain 59,481,400,000 cu.ft. of water and the estimated cost is $21,672,100.

Now 59,481,400,000 cu.ft. is only 0.4 of one cubic mile and to store eleven cubic miles would require approximately 27 times the capacity of those 17 reservoirs. Unless more favorable sites and cheaper storage capacity can be found, the Maxwell scheme points towards an expenditure of about $600,000,000.

Your committee believes that the lesson of the recent high water is that levees properly built according to the best engineering advice and practice are a success, and not a failure. Nearly all breaks occurred in levees that were practically overtopped. These levees had never been built to the adopted standard grade because of lack of money to complete them. Those levees that were built to standard grade and section did not break. Such levees required attention in some places because of sand boils due to seepage through porous strata underneath.

The first necessity is to build the levee high enough and wide enough. Levee engineers and the highest authorities of the U. S. Weather Bureau agree that had there been no breaks, the 1912 flood would not have gone above 48 ft. on the Memphis gage, or 3 ft. higher than it did go.

It is possible that there may be a greater volume of water for the levees to resist; but for any assumption that may be made as to the highest water that we should provide for, a levee can be built so high and strong as to resist it with perfect success, at much less cost than the same water can be taken care of in any other way. You can build all the levees 2 ft. higher and correspondingly wider for less than one tenth the cost of building any other works that will reduce the flood stage 2 ft. If your assumption as to the volume of water to be provided for is too small, the reservoirs or other works built to provide for it will fail much more surely than would levees fail, if built with the same factor of safety.

That there is a reasonable limit to the necessary height of levees is emphasized by the agreement of the authorities above referred to, that this year's flood would not have gone above 48 ft. at Memphis. To hold this water, the levees generally in this section should be raised an average of five to six feet.

In 1720 miles of levee in the lower St. Francis levee district and all the districts on both sides of the river below Memphis, there were only 9 miles of breaks. Of the entire 1720 miles of levee, 99½% stood intact against a stage of water much higher than it was designed to withstand.

Your Committee recognizes that, after the building of the levees high and strong enough, it is of the greatest importance to their stability that the seepage underneath shall be prevented or minimized; and while the details as to the best methods of accomplishing this are engineering questions which they are not prepared to solve conclusively, they believe that in isolated cases, some form of sheet piling might be advantageously used, and that at other places the principles of increased base width and of sub-levees, which have been very successfully used in some of the districts, should be applied.

Your committee justifies its position by a reference to the highest authorities, which they have studied carefully, to wit:

Humphrey and Abbott s Report.
Thomas and Watt
Major Chittenden
Testimony before Senate Committee 1898
Report of Board of U. S. Engineers on Deepening Channel 1909
Engineering News Editorials.

A careful study of the existing grades in their relation to the standard grades in the several levee districts, and of the levee heights and sections at the several breaks.

C. C. Pashby, Chairman,
A. L. Dabney
Elliott Long.

The resolutions drafted by the committee, and since adopted by the club, are as follows:

"Whereas, on May 18, 1912, this club was addressed by the Honorable George H. Maxwell, Executive Director of the Pittsburgh Flood Commission on matters covered by the Newlands River Regulation Bill, and

"Whereas, a resolution of unqualified endorsement of said bill was passed on that date by this club; and

"Whereas, the Levee and Reclamation Committee (a special Committee appointed by this club and charged with the duty of securing endorsements of this Bill from the other civic and business organizations in this City) after careful study of the Newlands Bill, the literature placed in the hands of the Committee, the speeches by Senator Newlands and others in Congress, the Government Reports and a wide range of technical writings on the subject treated, comes and requests a reconsideration by this club of its former endorsement, therefore

"Be it resolved, that this Club thanks Mr. Maxwell for the scholarly presentation of his interpretation of the provisions of the Newlands Bill, and

"Be it further resolved, that while this bill possesses many admirable features, such as its provisions for irrigation, reforestation, and the drainage of lands capable of being drained and cultivated, as a whole it is utopian in its character and does not differentiate between public improvements to which the United States Government has already committed itself by many years of substantial assistance, and such projects as impounding of waters for the purpose of flood prevention which have been almost universally rejected by the engineering profession, and which alone would require far in excess of the whole funds set apart in the division of the Bill where reservoirs are authorized, and

"Be it further resolved, that this Club does hereby qualify its endorsement of the Newlands Bill by requesting its amendment by striking out all provisions for the construction of levees, constructing artificial lakes, basins or reservoirs for the single purpose of impounding flood waters, constructing by-passes, flood water canals, waterways and other devices intended to divert the waters of streams for flood protection, and

"Be it further resolved. That this Club recognizes in the levee system of the lower Mississippi River a system of flood protection which has become standard practice the world over by reason of centuries of successful application, and

"Be it further resolved—That the Senators and Representatives in Congress from the lower Mississippi valley states are hereby urged to give their first and untiring attention to the passage by Congress of a bill which shall commit the United States Government to cooperate with the states or levee districts to the extent of a definite obligation to bear at least half the cost, in each district, of building the levees to an early completion, and to the building of a general system of bank revetment, with an appropriation of $8,000,000 per year for ten years, one half to be used for revetment for which the Government shall bear the entire cost and one half for levees to be paid for by the Government and the districts or States jointly, and that the present status of the Mississippi River Commission be left unchanged, and that all commercial bodies in the lower valley be requested through the press to endorse this policy.

We have given liberal space to this statement by the Memphis City Club because it relates to a matter of engineering interest which is being actively discussed and urged upon the public and because it gives the opinion of engineers of high standing, who have the experience and first-hand knowledge which best fits them to judge the questions at issue.

It cannot be too emphatically stated that without the trained expert judgment of the engineering profession, as to what works can and what cannot be profitably undertaken, the public is in danger of being led into the expenditure of enormous sums of money on schemes which will eventually be found to be impracticable.

We do not at all doubt that Mr. Maxwell and Senator Newlands and others who are engaged in this propaganda for National river regulation, forest protection, drainage, irrigation and similar enterprises for the public benefit are entirely sincere in their zealous work. More than that, ENGINEERING NEWS is on record as approving, to a certain extent, of Federal control of interstate streams, of the preservation of forests, and of reservoir construction for benefiting the regimen of rivers where topographical and other conditions make such reservoirs feasible.

But Nature sets a hard and fast limit on what the engineer may undertake with hope of profitable return; and when Mr. Maxwell or any other zealous worker for the public welfare plans great schemes without the conservative advice of competent engineers, he is likely to do great harm to those he seeks to serve.*

*Those of our readers who are desirous of seeing a detail statement of Mr. Maxwell's schemes are advised to obtain a copy of his publication "Maxwell's Talisman" for August, 1912, published at 132 St. Charles St., New Orleans, La. On the other hand, an admirable showing of the concensus of engineering opinion in the Mississippi Valley on the subject of Mississippi River control is given in the "Journal of the Association of Engineering Societies" for September. It contains the report of a special meeting of the Louisiana Engineering Society held on June 25 to consider the subject of flood prevention. Eight papers were presented at that meeting and the authors of all, without reserve, urged the maintenance and improvement of the levee system as the only practicable means of Mississippi River regulation.

The various schemes for public benefit which Mr. Maxwell and his associates of like mind are furthering have been to a

considerable extent pushed before public attention as part of the movement for the conservation of natural resources.

With this general movement, intelligently guided, ENGINEERING NEWS is in full sympathy. There is, however, one sort of conservation which has never had proper attention. We refer to the conservation of public credit. We may well seek to husband our natural resources so that the coming generation shall not be cold and hungry; but one important means to that end will be to pay for the works of conservation ourselves, and not incur debts for our children to pay.

Some of the conservation advocates are desirous of plunging the nation into debt at the rate of $50,000,000 a year for rivers and forests, double that sum for navigable waterways, as much more for good roads, and so on with a long list of attractive schemes for public welfare.

The excellent gentlemen who promote these schemes always figure out how each and all of them will return, directly or indirectly, an enormous interest on the investment, and no doubt believe in their own computations; but like other promoters, there often arise in actual experience unexpected factors which make the final result very different from that originally contemplated.

The generation which comes after us will not rise up to call us blessed, if the conservation works which we undertake for their benefit, and leave them to pay the debt for, should far outrun their estimated cost and should finally prove incapable of producing the benefits which were claimed for them.

The National Safety Congress

The subject of increased safety in industrial pursuits, and a reduction of the many dangers to life and limb, is now receiving a considerable amount of attention for both humane and economic reasons, and a Coöperative Safety Congress was held at Milwaukee, Wis., Sept. 30 to Oct 5, for the purpose of coördinating the various interests and lines of activity in this direction. In connection with the congress there was an exhibition of safety appliances and methods introduced by various manufacturing and other corporations to prevent injury to employees. This included an extensive exhibit prepared by the Industrial Commission of Wisconsin, and composed of photographs (largely of protective guards for machinery), pamphlets, devices, cautionary signs, etc. The congress was organized by the Association of Iron and Steel Electrical Engineers, which held its annual meeting in connection with the congress, the meetings and exhibits being at the Pfister Hotel. One result of the congress was to effect a permanent organization under the name of the National Council of Industrial Safety, with officers as follows: Chairman, F. C. Schwedtman (National Association of Manufacturers), St. Louis, Mo.; Vice-Chairman, L. R. Palmer (Association of Iron and Steel Electrical Engineers), Pittsburgh, Penn.; Secretary and Treasurer, Dr. L. W. Chaney (Department of Commerce and Labor), Washington, D. C.; Director of Safety Exhibits, C. W. Price (Wisconsin Industrial Commission), Madison, Wis.

The variety of subjects treated and the number of papers and addresses presented were such that we cannot undertake to consider them individually or in detail, but we summarize below some of the principal features of the papers and the general proceedings of this congress, held in the interests of public safety and welfare. The meetings opened with a dinner on Sept. 30, at which several addresses were made. The first day was devoted to papers dealing with the governmental aspect of the subject and with the safety measures already taken by the federal and several state governments. Mr. Crownhart (Chairman of the Wisconsin Industrial Commission) pointed out that the object of the employer is to make profit, and if he can be shown that safety measures result in increased profits he will be more directly interested in the matter. Further, attention paid to safeguarding employees should have some effect upon insurance premiums and compensations. John P. Gardner (Assistant Labor Commissioner of Minnesota) pointed out the necessity of keeping this movement free from politics. In some cases labor commissions and factory-inspection committees have been composed of men of no practical knowledge or men who are little more than ward heelers. Such cases result in direct harm, as they discredit the entire movement among employers and employees alike. This view was indorsed by other speakers. One point emphasized in several papers (at the various meetings of the Congress) was the fact that the human element, or the personal and individual factor, is one of the most important in the safety problem. Men will deliberately take chances, will be careless and negligent, and will in many cases regard the introduction of safety appliances as a personal affront. Therefore, a safety campaign must be conducted thoughtfully and diplomatically to avoid antagonizing the very men it is intended to benefit. And for the same reason, the campaign must be one largely of education. To apply safety devices is only a factor in the solution of the problem of accident prevention; a much more important factor is the education of employees (and men in general) to be habitually careful at all times, and not only in working hours.

SAFETY IN MINING

This session was presided over by Herbert M. Wilson (U. S. Bureau of Mines). Mr. Wilson and Mr. Moore (Cambria Steel Co.) presented papers on safety measures in the bituminous coal mines of western Pennsylvania and the mines of central Pennsylvania, respectively. The latter claimed that many large companies have carried out such measures in excess of the requirements of the law, but that the great difficulty encountered is in getting men to observe rules and methods prescribed to insure safety, while the foremen are very apt to look out for production first and safety second unless continual oversight and attention are given. Other papers dealt with safety measures in mines in Illinois and Alabama, and F. Armstrong (Penn Iron Mining Co.) described safety devices for electric mine hoists. H. H. Stoek (Illinois Mine Rescue Commission) referred to the fire-fighting and mine-rescue law, under which three rescue stations have been established while an instruction car (equipped also for rescue service) is sent from mine to mine. He pointed out, however, that the price of the product affects safety measures and that beyond a certain point it would be cheaper to close the mine than to operate it under complete safety conditions.

One of the most interesting papers was that by J. C. Roberts (Denver) on safety measures in the Rocky Mountain mining district. Nevada and New Mexico have laws requiring safety equipment at all metal mines, as a result of serious disasters; Washington also requires the inclosure and protection of all electric wires in mines. One company has reduced accidents materially by a classification of labor; that is, certain men do timbering, and nothing else, others do the tracklaying, the drilling, and the loading and shooting. In another case, electric shot-firing has been adopted, and the shots are not fired until all the men are out of the mine. This company has since had a very serious explosion, doing great damage to property, but causing no loss of life; if this had occurred under the earlier conditions probably 200 men would have been killed.

Strong endeavors are being made to persuade operators and miners to use "permissible explosives," instead of black powder; that is, explosives which have been tested by the U. S. Experiment Station at Pittsburgh. But some of the agreements with the men specifically mention black powder and do not provide for other explosives. There is objection also on account of the higher cost of the "permissible explosives," although it has been proved that the cost per ton of coal is no higher (and often much lower), owing to the greater power. He thought in no coal mine should naked lights be permitted. In Colorado (with only 15,000 miners), five out of seven disasters in two years were due to naked lights. Operators are training their men, but a difficulty is to make the men obey rules

and understand that the rules are for the safety of themselves and their fellows. The lower class of labor is increasing, but the men killed and injured are not the new and ignorant men; they are the experienced men who are hardened and careless of danger.

Safety in Transportation

The session devoted to this subject was presided over by R. C. Richards, C. & N. W. Ry., and an indication of the extent to which railways are now considering the subject of safety was afforded by the fact that the chairman and several of the speakers were not only railway officers but also members of "safety committees" on their respective roads. In his opening remarks, Mr. Richards stated that as a result of the methods on his road the numbers of persons killed and injured during a period of 20 months were, respectively, 26% and 29% less than during a similar preceding period. He suggested that while conservation of natural resources is important, the conservation of human life is even more important; and further, in the selection of enginemen and trainmen there should be at least as much care as in selecting engines and trains for the work required of them. The men began to take interest in the safety movement when they were made to see that they and their wives and families were the ones to suffer most from accidents, rather than the officers or the company. Nobody knows what the movement costs, and its value cannot be reckoned in money, but as a matter of fact his own road last year had to pay 120 less death claims and 540 less accident claims than during the previous year. The great majority of accidents to employees are of the minor class, and not in the train accidents which get reported in the papers. Several other speakers indorsed the views expressed and the importance of proper selection, education and discipline of employees.

In a paper on "Accidents Attributable to the Carelessness of Employees and How Best to Prevent Them," A. H. Boyd, Jr. (B. & O. R.R.) stated that the law limiting the hours of labor does not go far enough, as it does not limit the activities of the men after working hours; he suggested that the law should prohibit the men from engaging in other occupations after their regular work, although, of course, no law can compel them to take the necessary sleep and rest. Great attention should be given to securing the coöperation of employees in the safety movement, and educating them to understand that it is in their own interests and not simply for the protection of passengers or the company. Through the work of the safety committee on the B. & O. R.R. there has been a marked reduction of accidents due to men riding on engine pilots, boarding trains and engines on the wrong side, riding on brake wheels, etc. These are matters easily regulated by proper instruction and suspension.

In a paper on "Prevention of Accidents in Railway Shops and Engine Houses," Geo. Bradshaw described the methods in force on the New York Central R.R. Each shop plant has a safety committee, and the dangerous parts of machinery and machine tools are inclosed or guarded as far as possible. The lighting system is rarely efficient, and usually its efficiency is reduced by neglected maintenance; windows, skylights and electric lamps should be cleaned frequently. Foremen are held responsible for accidents occurring under their jurisdiction and which might have been avoided by proper methods or appliances. Mr. Winters (C. & N. W. Ry.) remarked that a great difficulty is to make the men understand that safety methods are in their own interests, and that each man should have some regard to the safety of his fellow workers, who may be endangered by his own carelessness. While "safety first" is now a watchword, it must be remembered that a foreman's duty is to get the proper output from his plant, and he needs continual assistance and attention if both output and safety are to be maintained at a high standard. Some remarks were made also by Mr. Belnap (Chief Inspector of Safety Appliances, Interstate Commerce Commission).

The subject of "Prevention of Accidents to Trainmen" was discussed by S. M. Braden (Gen. Supt., C. & N. W. Ry.), who referred to the tendency of men to evade or even disobey rules for their own safety, and to the tendency of labor organizations to support their members in case of trouble, regardless of whether the men were at fault or not. Double-tracking and additional tracks are safeguards to traffic, for it is difficult to handle high-speed and slow-speed passenger trains and high-speed and slow-speed freight trains on the same sets of tracks. He was inclined to favor the use of automatic stops, unless employees can be made much more reliable than at present; and he hoped for the development of a block-signal system operated by the train dispatcher, in order to eliminate the dangers of the cumbersome train-order system.

One speaker remarked that neglect, ignorance and open disobedience of orders are frequent, but are too often allowed to pass unnoticed. As to trainmen, J. W. Coon (B. & O. R.R.) said that in many cases a green lad is engaged who has no knowledge of the work and no great desire to learn; he is given a book of rules and told to study it, and later he is examined more or less thoroughly in his knowledge of the rules by a trainmaster. The present rules are ample if only the men were so thoroughly imbued with the necessity of obeying them that they would do this automatically or as a matter of course.

It has been said that if every rule was thus observed trains could not be got over the road. If this is so, it is a proof there is something wrong. He cited the case of a head collision in which every man of the entire crew of seven on a double-header freight either forgot or did not see the train-order governing the train's movement, although the rules required that each man should read and understand the orders. Another proof of the importance of the matter is that investigation shows that 90% of the accidents on the B. & O. R.R. were due to causes over which the company had no direct control. He strongly advocated frequent observation tests (sometimes called surprise tests) to see whether rules are being obeyed. The objections to these come from the careless men, not the careful ones. If a man is found at fault three or four times in such tests it is good evidence that he is not a fit man for the service or to be entrusted with responsibility for the life and safety of hundreds or thousands of people.

Safety in Manufacturing

Two sessions were devoted to this subject, and were occupied mainly by the presentation of papers. John Kirby, Jr. (Dayton Mfg. Co.), stated that the economic loss involved in industrial accidents had been estimated at $25,000,000 annually, while the possibility of reducing this loss was shown by the fact that in ten months the Pennsylvania R.R. had reduced serious accidents to its shop employees 63%, by introducing safety devices and conducting a campaign of education on lines of safety. The National Association of Manufacturers has done much through its committee of investigation, the information obtained by which is supplied free to members and at a low cost to non-members. Mr. Trix (President of the American Injector Co.) spoke of the work of the Employers Association of Detroit, which employs its own factory and fire-protection inspector to examine the plants of its members periodically. His own plant was one of the first inspected, and he had felt that nothing wrong could be found; but open coal holes, uncovered gears, foundrymen wearing low shoes (affording no protection against hot metal splashed on the floor), and other possibilities of danger were indicated on the inspection. A projecting setscrew on a revolving shaft was noted also, but both the shop foreman and Mr. Trix thought this of so little danger that no change need be made; however, a few days later this foreman's sleeve was caught and his arm badly torn. Similar defects were found in every plant, no matter how well equipped or well managed. Employers formerly did not realize the economic loss in injuries and payments for damages, and it

is still difficult to get the employees to properly use safety methods when installed. In the case of a subway built to eliminate the necessity of men crossing the tracks, very few men used this until a fence was erected to keep them off the tracks. As to fire protection, in two cases where the owners of the plants ignored the recommendations of the inspector, fires occurred which not only caused expensive property loss but the destruction of entire collections of patterns for castings, involving enormous trouble and loss of time and money in their replacement. Thus the safety movement involves the saving of property as well as of lives.

Mr. Alexander (General Electric Co.) made it very clear that the installation of safety devices is only one means of insuring safety, and may be carried to such an extreme as actually to make men careless. Of much greater importance is the education of the men in habits of care and forethought. He described also the safety organization of his company, with its numerous large plants. He strongly urged manufacturers to take up the matter seriously; if they had done this some years ago, they would have saved themselves from much adverse legislation. Such compulsory legislation entails ill-will of the public and the employees against the employers, while if the latter had adopted remedial measures voluntarily, they would have insured good will. Mr. Miles (Racine-Sattley Co.) spoke on the apprenticeship system and the decline of this system in this country, so that boys leaving school have no way of really learning a trade. The labor unions and the closed-shop are largely responsible for this. It is generally assumed that most boys go to work as soon as they leave school because their parents cannot afford to support them, but in Massachusetts it has been found that 76% could have stayed at home long enough to acquire mechanical training if any means of training had been available. He strongly advocated the establishment of continuation schools. Mr. Parry (Indianapolis Tire Co.) described the "industrial betterment special," which is a train of six cars equipped with models, motion pictures, photographs, literature, etc., relating to accident prevention, fire prevention and industrial education. This will be sent to various industrial centers, where lectures and exhibits will be given, especially for the education and benefit of workmen, and in order to reduce the present economic waste.

Mr. Bird (General Manager of the National Association of Manufacturers) thought that the campaign should begin with interesting the workman, rather than with the employer or superintendent. Foremen and shop superintendents have enough to do to look after orders and production, and have little time for considering safety methods. The safety committee should be composed of workmen and should report to the employer; and they should do this in their working hours. Mr. Avery (Avery Mfg. Co.) outlined the employment and safety organization at his plant, under the new Illinois compensation and liability act. He pointed out that lower expenditure for compensation means higher profit. Mr. Van Schaak discussed the relation of insurance to workmen's compensation under recent legislation, and Mr. Adderly remarked that an investigation made by the National Association of Millers (in regard to insurance methods) showed that 90% of the accidents in mills were avoidable. Mr. McKee outlined the means taken by Fairbanks, Morse & Co. to prevent accidents in machine shops and foundries.

It was shown by some of the speakers that there is more difficulty in interesting minor officials (such as shop foremen and superintendents) than the higher officials, as the former feel that the work will add to the cost and reduce the output of their departments. The safety committee should be backed by authority, and for this reason the Commonwealth Steel Co. has one of its directors at the head of this committee. One great point is to secure the interest and coöperation of the men, and to make them realize that the movement is for their own direct and personal benefit and not merely to benefit the company or the employer.

The American Road Congress

The American Road Congress, held at Atlantic City, N. J., Sept. 30 to Oct 5, was the first joint convention under the combined auspices of the American Association for Highway Improvement, the American Automobile Association, and the National Association of Road Machinery and Material Manufacturers, with the more-or-less hearty coöperation of some 30 state and local highway associations whose names adorned the advance literature of the Congress. Some seven hundred persons attended the sessions, which were held in the auditoriums on the Million-Dollar Pier and viewed the exhibition of road machinery and materials which occupied the entrance halls of the pier.

The several section meetings, held every morning and afternoon of the six days of the convention, were classified under different subjects pertinent to road administration, construction and financing and directed by different associations interested in the respective subjects. Thus Monday and Tuesday were "Road Users' Days" and the meetings were under the supervision of the American Automobile Association, Wednesday afternoon was the "Legislative Section" under the auspices of the American Bar Association, and Thursday afternoon was the "Highway Engineering Education Section," under the auspices of the Society for the Promotion of Engineering Education. The remainder of the sessions on finance, administration, construction and maintenance of streets and roads were distributed throughout the week and were under the direction of the American Association for Highway Improvement.

This program was somewhat more ambitious in arrangement than in execution because the attendance was very light in the first part of the week, when the nonengineering sessions were in progress and a number of the papers on the program were not presented, while the discussion was notable by its absence.

Toward the end of the week, when the engineering papers were scheduled, many more were present and the interest displayed in the sessions much greater, though even then the amount of discussion was quite small.

One hopeful thing could be noticed in the meetings on road administration and finance and that was the insistence by high executive road officials on a saner system of highway financing than is sometimes practiced and quite generally advocated by a certain type of good roads enthusiast. Col. William D. Sohier, Chairman of the Massachusetts Highway Commission, voiced this sentiment when he said that provision must be made for depreciation of road property just as in all other property and that the issuance of 30- or 40- or 50-year bonds, all the proceeds of which are expended on the construction of a road that will last, unmaintained, possibly 10 years, is a crime against good finance and a sure way of killing future road construction.

President Taft was expected to address the Congress but was unable to be present. Gov. Woodrow Wilson, however, represented the presidential candidates, in a brief address of welcome from the State of New Jersey. In view of the possibilities of next election day, the following remarks of the Governor are of interest to those who anticipate future increases in federal aid for roads:

> The question of highways is one of the few great instrumentalities of our public and our communal life with which the Government is of necessity connected. I see that we must do what we have been very backward in doing as compared with other nations. We must more and more engage the Government in providing the general facilities of the common life. We have never doubted that the Government had the right to supply these facilities which private endeavor has never been expected to supply. It is of the most fundamental importance that the United States should think in big pieces, should think together, should think ultimately as a whole, and I feel in my enthusiasm for good roads something of the old opposition that there always has been in me to any kind of sectional feeling. In proportion as we are confined within the walls of one hostelry or city or state we are provincial, and national thought cannot successfully build itself upon

those foundations in a way that will be permanent. So I believe the development of great systems of roads is a task of statesmanship. I believe that it is the proper study for the statesman to band communities together and open their intercourse so that it will flow with absolute freedom and facility. You cannot rationally increase the prosperity of this country without increasing the road facilities of this country.

It may be remarked that while there were to be heard frequent vociferous demands for large federal appropriations for good-road construction, the general sentiment of the speakers was that local financing, with state aid, must be the main reliance for road building.

The sessions of the Construction and Maintenance Section on Friday were presided over by Col. E. A. Stevens, State Commissioner of Highways of New Jersey, and the day opened with an interesting historical paper by Col. Specer Cosby, Corps of Engineers, U. S. A., recording the work done by the U. S. Army and the Corps of Engineers on road construction. The famous old National Turnpike built in the early years of the last century from Baltimore to Columbus, Ohio, cost nearly $10,000 a mile to construct, a large amount in that era of low prices—many of the pioneer roads built by the army, however, cost less than $100 per mile.

Prof. E. B. McCormick, of the Kansas State Agricultural College, reported some recent experiments on the tractive resistance of various road surfaces. On a good earth road in good condition the resistance was about 100 lb. per ton, and it was nearly as high as this on a macadam road when covered with dust.

W. S. Keller, State Highway Engineer of Alabama, who is a brother to Helen Keller, described the very satisfactory sand-clay roads which are being built in the South at a cost of $500 to $1500 per mile. For the sections in which they are constructed these roads are far more satisfactory than macadam roads would be.

On Friday afternoon, Albert Goldbeck, of the U. S. Office of Public Roads, described the latest methods of selecting and testing gravel and stone for road work. Dr. A. S. Cushman read a paper on the qualities of bituminous materials for road construction.

At an evening session, Theodore A. Randall read a paper illustrated with lantern slides on the proper methods of laying brick pavements. Glenn Brown, Secretary of the American Institute of Architects, exhibited a collection of beautiful lantern slides, illustrating the ornamentation of roadways by planting trees and shrubs. Linn White, Engineer of the Chicago South Park Commission, also gave a lantern-slide paper, showing the methods adopted in making and maintaining park roadways in Chicago.

Exhibition

The exhibition consisted of about 50 road contractors, material and machinery manufacturers, several trade and technical papers, the exhibits of the U. S. Office of Public Roads and of a half dozen states. The road-machinery exhibits were particularly good and comprehensive, embracing practically all of the latest road rollers and scarifiers, concrete and asphalt mixers and stone-crushers. The brick, cement, oil and tar interests were also well represented. The federal government's booths, showing model roads of all ages and various methods of road and bridge construction, were perhaps the most observed of all the exhibits, but the state sections, with the exception of one or two, did not come up to the standards announced.

Enlarging the Kaiser Wilhelm Canal, Kiel, Germany

The Kaiser Wilhelm Canal, which was finished in 1895 by the German government and which connects the North and the Baltic Seas near Kiel, Germany, is now being enlarged to accommodate ships, particularly warships, of the present extreme dimensions, which were not contemplated in the original design.

In its narrowest section, the present canal has a bottom width of 72.3 ft. and a depth of 29.5 ft. and a water surface breadth of 210 ft. After the present reconstruction work is completed, which will be in 1915, the canal will have in its narrowest section a bottom width of 145 ft., a depth of 36 ft., and a water surface width of 335 ft. This increase gives a water section of 8900 sq.ft. instead of the previous 4450 sq.ft., or double the previous size.

For purposes of comparison, it may be stated that the Suez Canal has been increased from a water surface width of 190 ft. to 262 ft., from a depth of 26.2 ft. to a depth of 36 ft., and from a water section of 4300 sq.ft. to 7000 sq.ft., and that a proposed increase in depth of 2 ft. has just been announced. The narrowest section of the Panama Canal has a water surface width of 300 ft. and a depth of 40 ft., which gives a water section of 11,800 sq.ft. The enlargements of the Kiel and of the Suez Canals are based on figures which show that a canal requires at least five times as great water section as the greatest cross-section of a ship which passes through it.

In addition to the enlarged section in the Kiel Canal, the government is also straightening out sharp curves and increasing in number and in size the basins where the boats may pass. The amount of earth to be excavated is estimated to be about 120,000,000 cu.yd. and some 7000 or 8000 workmen will be required. Besides the above work, the two locks at the extremities of the canal are to be replaced by new structures. The old locks, at Brunsbuttel on the Elbe and at Holtenau, near Kiel, on the Baltic, are 475 ft. long, 82 ft. wide and 33 ft. deep. The new locks, which are to be constructed in duplicate, will have a useful length of about 1080 ft., with a width of 148 ft. and a depth across the sills of 45.5 ft. About 600,000 cu.yd. of concrete and stone masonry will be required in their construction. Each lock will be furnished with an intermediate gate, which divides it into two chambers of 328 ft. and 730 ft. length, respectively. Finally, considerable work will be done in providing additional and larger crossings over the canal. A number of new bridges will be constructed and many drawbridges will be raised and made fixed structures.

The total expense involved in the enlarging of the canal is estimated at $56,000,000, as compared with the initial construction cost of only $39,000,000. The toll charges on the canal have earned a small surplus over a fair interest on the original cost of the construction.

The Permanent Fireproofing of Fabrics was described, on Sept. 10, by W. H. Perkin, of Manchester, England, in a lecture before the International Congress of Applied Chemistry at New York City. He described a long series of experiments which had been made in connection with the fireproofing of "flannelette." It was known that rinsing a garment after washing in the ordinary way in a solution containing alum, or starching it with a starch containing alum, rendered the fabric fireproof, but this protection lasted only until the protecting salt was washed out. The aim, therefore, was to secure a nonsoluble, fireproofing agent. Finally, the following successful process was developed.

The fabric is run through a solution of sodium stannate of approximately 45° Tw. (density of 1.22), so that it becomes entirely impregnated. It is then squeezed to remove extra solution, passed over heated copper drums for drying and then run through a solution of ammonium sulphate of about 15° Tw. (density of 1.08), and again squeezed and dried. The fabric now contains precipitated stannic oxide and the material carries sodium sulphate, the latter being removed by passage through water. The fabric is then dried and subjected to ordinary processes of finishing. A long series of severe trials have conclusively proved that this material is permanently fire-resisting. No amount of washing with soap and hot water will remove the stannic oxide, which seems combined with the fiber. Of course, the fabric can be burned by subjecting it to the continued action of flame, but the combustion is not easily propagated and there is none of the flashing seen with ordinary cotton fabrics. The treatment has no effect on delicate colors which may be used on the fabric, and the fibers of the material are strengthened about 20% by the process. The cost is about 2c. per yard for treatment.

The Westport Wreck on the New York, New Haven & Hartford R. R.

The Boston-New York express train, which left Boston, Mass., on Oct. 3, at noon, via the Boston & Albany R.R. to Worcester and Springfield, was derailed about 1000 ft. west of the Westport-Saugatuck station (about 10 miles west of Bridgeport, Conn.), and the first five cars, a baggage car, a mail car and three parlor cars, were completely destroyed. Seven persons were killed, including the engineman, fireman, a mail clerk and four women passengers, and some 50 other passengers were more or less seriously injured.

The wrecked train was the second section of the express and was following the first section with a 13 min. interval. Leaving Bridgeport on the westbound inner track No. 1 (See sketch, Fig. 4), some minutes late, the train approached the crossover to the outside track No. 3, just west of the Westport station, at a speed estimated by spectators to have been between 50 and 60 miles per hour. The entire train appears to have taken the switch without damage to the track, but just west of the crossover is the beginning of a long curve in the opposite direction to the turn of the crossover, and here the locomotive apparently left the rails and soon turned over on its side.

The locomotive tender was thrown entirely clear of the track to the right and the baggage car following shot past the overturned locomotive before overturning. The cars following, the mail car and one of the New York, New Haven & Hartford R.R. Co's. chair or parlor cars, plunged directly into the overturned locomotive and immediately took fire. In this parlor car were the four women passengers whose lives were lost; the other passengers succeeded in making their escape before the fire reached them. The two following cars, which were also wooden parlor cars, were overturned and destroyed by fire. Another parlor car and four coaches were not seriously damaged.

There is convincing evidence that the switch and crossover, which the railway officials state had a No. 10 frog, were in satisfactory condition, and that the switch and interlocked signals had not been changed since the passage of the first section of the train but a few minutes before. The operating rules of this railway call for a speed at crossovers of not more than 15 miles per hour. A glance at the sketch plan, Fig. 4, will show that a speed of more than 25 miles per hour over such a sharp crossover in such a location would be exceedingly dangerous.

The distance signal for the crossover is located about 3000 ft. east of the Westport station and the home signal a few hundred feet east of the crossover switch.

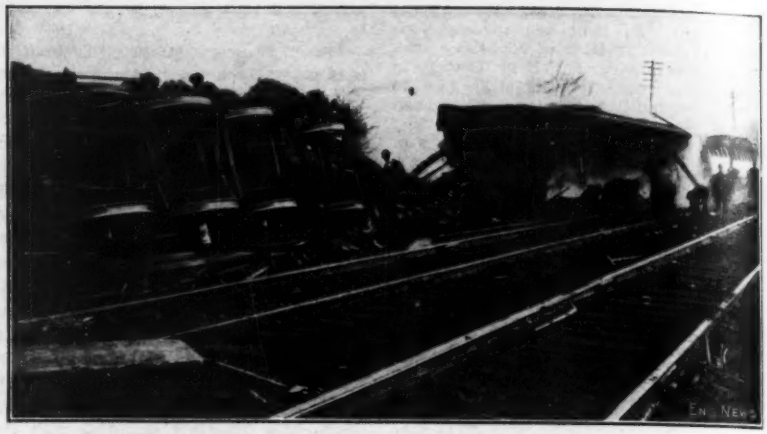

FIG. 1. GENERAL VIEW OF OVERTURNED LOCOMOTIVE AND BURNED CHAIR CARS

Both are of the high semaphore type and visible for several thousand feet over a straight track. The evidence is practically conclusive that these signals were properly set at caution and stop respectively. A small dwarf signal at the switch point permits the engineman to proceed at 15 miles per hour against the stop signal. The blame for the accident is therefore placed by the railway company on the engineman for disregarding the signals set against him; although previous to this time the record of the engineman is said to have been that of a careful and trustworthy man who had had 27 years experience as a locomotive engineer.

Readers who remember the wreck of the Federal express at Bridgeport on July 11, 1911,* will be struck with the remarkable coincidences of both circumstances and locality. This Westport wreck, however, occurred in broad daylight, about 4:45 p.m., so that there can be no question as to the ability of the engineman to distinguish the signals.

The sketch plan, Fig. 4, shows some resemblances to the scene of the Bridgeport wreck, Fig. 5, which are worthy of attention. There are the same abrupt crossovers, at Bridgeport at the end of a curve, at Westport at the beginning of a curve. In each case there is a crossover to a siding just beyond the main-line crossovers, and in each case an open-floor girder bridge was shortly ahead of the place of derailment.

FIG. 2. BOILER OF WRECKED LOCOMOTIVE SHOWING NO EVIDENCE OF AN EXPLOSION

The illustrations in Figs. 1, 2 and 3 show the effect of the wreck upon the wooden cars and the locomotive. Contrary to numerous press reports the locomotive boiler did not actually explode, as is plain from Fig. 2, which shows the boiler intact except for a small hole near the cab, which it is plain was punched through from the outside; the crown sheet of the firebox was also ruptured. There is some evidence of an explosion, both from the testimony of witnesses and in the damage to near-by buildings, but

*Eng. News, July 13 and 20, 1911.

FIG. 3. RESULT OF WRECK ON WOODEN CARS

this so called explosion was probably due to the escaping steam through the ruptured boiler. Some parlor cars were equipped with Pintsch and some with acetylene gas, but the tanks are reported to have remained intact, save one, which was flattened out and doubled up.

The cause of the wreck is now being investigated by both the Interstate Commerce Commission and the Public Utilities Commission of Connesticut. It is also reported that the Brotherhood of Railway Engineers will conduct an independent investigation in defense of the

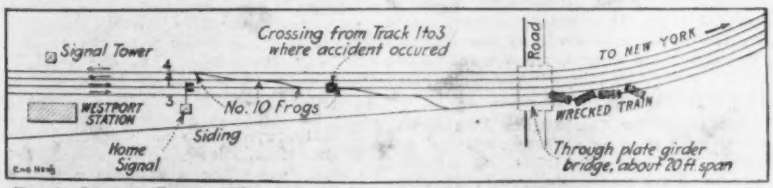

FIG. 4. SKETCH PLAN OF TRACKS AT SCENE OF WRECK AT WESTPORT, SEPT. 3, 1912

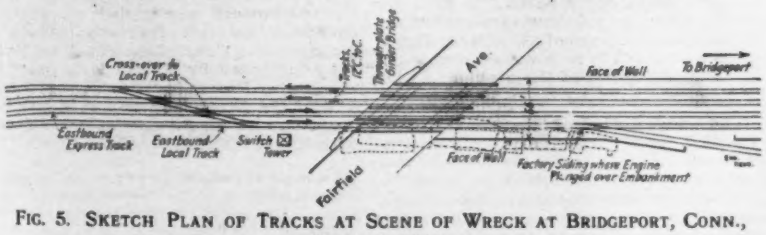

FIG. 5. SKETCH PLAN OF TRACKS AT SCENE OF WRECK AT BRIDGEPORT, CONN., JULY 11, 1911

(Reproduced from Engineering News, July 20, 1911)

dead engineman. As to the cause of this accident the following conclusions of the Interstate Commerce Commission in regard to the Bridgeport wreck of July, 1911, are of interest:

"The report states that the controlled manual block-signal system was in good working order, and that ample warning was given the engineer that the crossover was to be taken. The interlocking plant is not equipped with approach locking to prevent signalmen changing the switches while a train is closely approaching them, but there is no evidence in this case to show that the absence of approach locking in any way contributed to this accident. The crossover frogs were No. 8. The accident might have been avoided by using No. 18 or 20 frogs, but the location of the crossover near the P. T. of a curve made such a long cross-over impractical. The signals and rules, had they been observed, were ample to prevent such accidents; the accident was due to the disregard by the engineman of the rules and signal indications; in all locations where accidents are likely through nonobservance of the rules and signals, automatic train-control apparatus should be provided; in the absence of such control, on tracks where high-speed trains are run, switches should not be set to divert trains from one track to another on a crossover not safe for high speeds, until the train has been brought to a stop; all interlocking plants where high-speed trains are operated over facing switches should be provided with approach locking."—[Engineering News, Aug. 24, 1911, p. 241.]

Hints on the Engineering of Men—In the organization of your work and blocking it out, there are three things of prime importance: Personality, organization and treatment. If I may reverently paraphrase—"There abideth personality, organization and treatment, these three, but the greatest of these is treatment."

The personality of the superior at the head of an organization is a very important matter. The bigger the organization, relatively, the more important it is to have the right kind of man, but even if there be but one gang of men, the personality of that gang boss is very important.

In an organization, I believe in military ideals. If you can imagine a military organization without the shoulder strap, then that is what I believe in, and I have worked with army officers a great deal. There must be discipline, there must be responsibility placed upon one head, and it must be recognized. If you cannot respect the man above you, you must at least respect his position. Don't forget that. That is an army idea.

The simplest form of organization is that for the project engineer. The first requisite, in my judgment, is to put a man in charge who has an engineering education, whether he acquired it in college or somewhere else. I do not believe in putting a man on a job who has not been in that particular kind of work. I do not believe in putting him in charge because he is simply brilliant. I would put a man in charge who has had experience, and I want him to be 40 years of age. He must know human nature. He must be in full charge of all the features of the work.

If you divide the responsibility at all, then when there is a mistake made there is no one you can hold responsible. Your Chief of Party should always be able to do any work under him fairly well. In order to do that, he must practically come up through the ranks. His first assistant must be but a little less able. He must be an understudy. In temporary illness he must be able to carry on the work. There should always be an understudy in every position.

If you expect to control labor in general—and I am now speaking of ordinary labor—three things are necessary: First, there must be no dispute but what you have the authority, and the men must know that. You are in authority, you are the boss, if you are handling men, whether a few or a few hundred men. Battles have been won by a poor commanding officer, but no battle was ever won by a debating society.

A second requirement is that you must be absolutely right—legally, morally right. That the right is on your side and beyond dispute.

Having the authority, and being in the right, the final thing in handling labor is that you must not be afraid. Let a hundred men come together, average men, and it is said that in 30 days one of that hundred men will be the leader. Now, I never knew a leader of that sort to be a coward. So, as an engineer of men, you must have that leadership quality. You will be surprised to see what you can do with it. I believe many of us fail right there. We are afraid. Afraid of the law; afraid of damages; physical fear; fear that something is going to happen to us. Right makes might more than we think.—[From a talk before the Cleveland Engineering Society by Willard Beahan, First Assistant Engineer, Lake Shore & Michigan Southern Ry., Cleveland, Ohio. Sept. "Journal" of Cleveland Engineering Society.]

A Cave-in Occurred in Richmond, Va., on Sept. 30, and buried four laborers who were working in a trench.

The Collapse of the Tunnel Walls in tunnel No. 7 on the Great Northern Ry., near Basin, Mont., caused the death of two railroad laborers and the injury of three others on the work train, which was caught in the accident. It is reported that the line was tied up for five days after the accident, which occurred on Sept. 29.

The Derailment of a Passenger Train of the Bay of Quinte Ry., while traveling on the tracks of the Kingston & Pembroke Ry. near Kingston, Ont., on Oct. 2, resulted in the death of one passenger and the injury of several others.

A Passenger Train Derailment on the Louisville & Nashville R.R., near Elkmont, Ala., caused the death of one man and the injury of 13 others, on Oct. 1. The entire train, except the locomotive and the last coach, left the rails and was ditched. Fire broke out in the wrecked train and some of the Pullman car passengers barely escaped with their lives.

Fire Destroyed Pier 80, Delaware River, at Philadelphia, Penn., on Oct. 1, and the loss is estimated at $1,000,000 in round numbers. The pier is owned by the B. & O. R. R. and is used by the Hamburg-American and the Italia steamship lines. The fire fighting equipment called to the scene was unable to control the progress of the flames on the pier itself, but did succeed in preventing their spread to adjacent piers.

The Sinking of the British Submarine "B-2" by the Hamburg-American liner "Amerika," cost the lives of 15 out of the 16 men on board the boat. The B-2 was participating in submarine manoeuvers, off the coast of Kent, when the accident occurred. According to press dispatches the submarine rose to the surface directly in front of the liner, which was traveling at high speed. In spite of the fact that the engines on the "Amerika" were reversed and efforts made to steer clear of the smaller boat, it was struck and cut in two, and sank immediately. Later a single survivor was picked up, in and exhausted condition, after hours in the water.

Aeroplane Fatalities for the month of September mounted to the surprising figure of 18. This makes a total of 192 since the death of Lieutenant Selfridge of the U. S. Army in 1908. The last week of the month brought fatal accidents to military aviators in the service of the German, Italian, English, and American armies. Among the notable victims was Charles Voisin, well known as a designer of a biplane type of flyer. It is reported that 57 military aviators have now been killed, 30 of whom were attached to the French army and five to the American.

Up to Oct. 8, five men were killed in aeroplane accidents in this month, bringing the grand total to 197. The number of victims is distributed thus: 1908, 1; 1909, 4; 1910, 36; 1911, 73; 1912 (9 mo.), 83.

The Irondequoit Creek Section of the New York State Barge Canal, which is being temporarily repaired after the serious break of six weeks ago, was partly filled with water on Oct. 3 with the intention of opening the canal again for through traffic. When about 3 ft. of water had been let into the repair section, serious leaks developed through the floor of the timber flume and the water washing onto the newly made sand embankment caused some slight settlement in places. The timber section was immediately dammed off and the water withdrawn therefrom. Immediate steps were taken to waterproof that section more completely and at the time this issue went to press it was expected that the canal would be open for traffic by Oct. 11.

As noted in our issue of last week, the bottom of the timber flume is made of 3-in. planks and the sides of 6-in. timbers. In addition to these timbers, the bottom and sides were covered with one layer of three-ply roofing paper well tarred and over this was nailed a layer of 1¼ in. x3¼-in. flooring, which was again covered with tar. It is stated that an additional waterproofing of more tar will be applied to the whole length of the flume in order to make it completely watertight.

An Accident to the Lachine Canal Lock gates at Montreal, Que. in the early morning of Sept. 24, caused damage to two lake freight steamers, a sand barge and the pier of the Wellington St. bridge. The "Glenmount," a lake freight-steamer of 1200 tons register was passing up the canal at about 6:30 a.m., followed by the "Nevada" of the Canadian Lakes Line Co. When the "Glenmount" had entered the St. Gabriel or No. 3 lock at Seigneurs St. the lower gates were closed and the lock flooded in the usual manner. The "Glenmount" was waiting for the upper gates to be opened when the "Nevada," which had followed into the lock below, drove its bow into the lower gates of lock No. 3, carrying them away. The water in the upper lock was some 10 or 12 feet above the water level of the "Nevada" and swept the latter against the sides of the lower lock and carried the "Glenmount" down upon it. The flood also carried away the gates of the lower level locks and dashed a sand barge against the pier of the Wellington St. bridge, damaging both considerably. As a result of the accident the two pairs of gates sustained damage which caused a traffic tie-up of several days. It is considered fortunate by the canal officials that the damage was not more severe, as it would have been had the two steamers become jammed together in the lock.

A Record for Continuous Flight was made on Oct. 6 by a French aviator, according to Paris dispatches. It is stated that the start was made from Valenciennes near the Belgian border at 5:59 a.m. and the finish occurred at 5:38 p.m. at Biaritz near the southwestern extremity of France, a distance of 570 miles. Three stops were made to renew the fuel supply. The average speed of the aeroplane was 49 miles per hour.

The Conservation of the Natural Waters of Pennsylvania and the prevention of floods in that state is to be made the subject of a series of lectures which are to be delivered without charge through the state under the auspices of the newly organized Water Conservation Association of Pennsylvania. The addresses will be delivered by Morris Knowles, of Pittsburgh, one of the engineer members of the Pittsburgh Flood Commission, which has recently made a report on flood prevention at Pittsburgh.

A New Idea in Railway Service, designed to attract those who travel for pleasure, is to be put into effect by the Chicago & Northwestern Ry. and the Union Pacific R.R. in February, when a special train to be operated only during daylight hours will be placed at the disposal of travelers from Chicago to California. At night the train will be parked at sidings and the journey continued at the breakfast hour the following morning. The time required from Chicago to Riverside, Calif., will be five days.

The Grand Valley Reclamation Project in Colorado is given a new status by a contract, recently approved by the Acting Secretary of the Interior with the Grand Valley Water Users Association, relating to construction. This marks the close of a long struggle of the citizens of that section for the extension under government reclamation of rich horticultural districts. Owing to the fact that the main canal must pass for several miles through a section of fine orchards, portions of which must be destroyed, many obstacles have been encountered in securing rights of way. Numerous alternative plans were studied before the final agreement of terms and location. This contract is made contingent to the adoption of certain amendments to the articles of incorporation of the Grand Valley Water Users Association. Irrigation of some 53,000 odd acres of land is contemplated in Mesa County, Colorado. This involves the construction of (1) a diversion dam in the Grand River, (2) about 60 miles of main canal, and (3) a series of short tunnels in the first few miles of the canal, having an aggregate length of 20,000 ft. It is expected that power will be developed at drops in the canal and used to pump water to lands lying too high to be served by the gravity system.

A Dynamometer Car is being designed for the Japanese Imperial Railways, by Prof. E. C. Schmidt, in charge of the Department of Railway Engineering of the University of Illinois. This car will be constructed in this country, and it is expected to be delivered next spring to the representatives of the Janapese Government.

The car is to be 48 ft. long, 8 ft. 6 in. wide, and adapted for 3 ft. 6 in. gage but with provision for changing later to 4 ft. 8½-in. It is to be equipped with vacuum brakes, and drawbar buffers, journal boxes, etc., made in accordance with the Japanese railway standards. The car will be a hydraulic-dynamometer type with recording apparatus permitting a measurement of tractive efforts up to 80,000 lb. It will provide also for measurement of speed, time, distance, vibration, buffer thrust, etc. The maximum speed for which the equipment will be designed is 85 miles per hr. An axle generator and storage battery will supply current for operating the recording apparatus and for lighting. General specifications have been furnished by S. Matsuno, Chief of the Motive Power Section, Central Division of the Japanese Imperial Railways; the financial arrangements were made with Mitsui & Co., Ltd., of New York.

The sale of surplus power from the generating station of the North Dakota irrigation pumping project to the city of Williston, for municipal purposes, has been approved by the Secretary of the Interior. The irrigation season on this project is confined almost exclusively to June, July, and August, so that the power plant has been entirely idle during nine months of the year and full capacity has not been required for more than two or three weeks in the middle of the season. There is thus a large amount of surplus power capacity available for lease or sale under the provisions of the law. The contract drawn provides that the city of Williston may use up to a maximum demand of 600 kw. (approximately half the capacity of the plant) in any month except June, July and August. During these three months the city demand is limited to 300 kw. From June 20 to Aug. 1

of each year, right is reserved to cease furnishing power if the irrigation needs demand such action.

If this contract is finally executed, the annual shut-down of the plant will be obviated and the Government will be able to keep its operating force continuously at the plant instead of reorganizing every year as at present. The earnings from the contract are expected to take care of the total operating expenses and also to furnish a fair proportion of the depreciation charges. On the other hand, the contract will enable the city of Williston to offer inducements to industries beneficial to the irrigation project.

The Public Health Service is the new title for the Public Health and Marine-Hospital Service of the United States, which at an earlier day was known as the Marine-Hospital Service of the United States. The latest change in name, brought about by a short Congressional Act approved Aug. 14, 1912, is accompanied by an increase in powers of the service and of the salaries of the commissioned medical officers of the Service. The single sentence enlarging the powers of the Service is as follows:

The Public Health Service may study and investigate the diseases of man and conditions influencing the propagation and spread thereof, including sanitation and sewage and the pollution either directly or indirectly of the navigable streams and lakes of the United States, and it may from time to time issue information in the form of publications for the use of the public.

The increases in salaries will raise the Surgeon General (the head of the Service) to $6000 a year; his assistant to $4000; ten senior surgeons to $3500; passed assistant surgeons to $2400, and assistant surgeons to $2000; but in addition, each class of surgeons, except the chief, is to have a 10% advance for each five years of service, up to 40% total increase, except that the assistant surgeon general, senior surgeons and surgeons cannot be paid more than $5000, $4500 and $4000, respectively. These increases, we understand, place the salaries in this Service on a par with those of the medical services of the Army and Navy—a consummation long devoutly wished by these attaches of the Treasury Department.

Competitive Designs for a Street Viaduct were recently received by the Board of Aldermen of Vancouver, B. C., and the following prizes were awarded for the best designs:

	Estimate	Engineering
1st. Mr. C. A. P. Turner, Winnipeg, Acceptance of plans under usual terms of payment..	$451,600	$22,400
2nd. Waddell and Harrington (Kansas) Prize $750.....	485,300	24,700
3rd. Wilson, Lake & Bentall (Van'r) Prize $500.....	553,330	26,350
4th. Mr. A. E. Stone, (Van'r) Prize $250.....	521,711	26,080

The other firms supplying designs were Messrs. Cartwright-Matheson & Co., Gordon & Taylor, Dutcher, Maxwell & Co., Van Sicien & Macomber, and S. Hancock, all of Vancouver, B. C. The Vancouver "News-Advertiser" says that Mr. Turner is to act as engineer for the erection of his design for a fee of $22,400, and gives the details of the work which he is to do as follows:

That he prepare all plans and submit a duplicate set for the city engineer; provide all engineering assistance, including transitmen, linemen, rodmen and chainmen; provide a first-class fully qualified steel and concrete expert; furnish a guarantee of design for the sum of $100,000; open office and supply all furnishings, staff, etc.; prepare all specifications in triplicate; be fully responsible for all the work until the final completion of the undertaking, and its acceptance by the council; allow free access to office and works in progress to the city engineer or authorized members of his staff; undertake this work for a lump sum; furnish all shop inspectors for steel work, and that in the event of the bids over-running the engineer's estimate the council shall have every right to cancel the contract without compensation to the engineer for his plans, etc.

The design submitted by Mr. Turner was for the "Mushroom" type of floor construction, the viaduct being supported on columns, with a steel lattice truss where the viaduct is carried over the Canadian Pacific Ry. tracks. These trusses are to be encased in concrete and economy is secured in the design by making a comparatively shallow truss, cantilevering the girders over the support and suspending the spans therefrom.

A Modernized Calendar was advocated at the fifth International Congress of Chambers of Commerce, at Boston, Mass. The proposition is for a calendar year of precisely equal divisions and subdivisions, with each day of the month always the same day of the week, made possible by establishing New Years as a day outside the regular cycle of dates and the day following as Jan. 1. This change, it is claimed, would be a great help in commercial and business work of all kinds and it is of special interest as it would involve the invention of a thirteenth month.

Personals

Mr. Willis J. Dean has opened an office at 619 Timken Bldg., San Diego, Calif., as a consulting structural engineer.

Mr. John J. Deimling, Chief Engineer of the Pere Marquette R.R., has resigned to become Assistant Chief Engineer of the Michigan Central R.R.

Mr. T. J. Burke, formerly Supervisor of the Lehigh Valley R.R., at Towanda, Penn., has been promoted to be Division Engineer, with headquarters at Auburn, N. Y.

Mr. Elmer H. Olson has been appointed Assistant Engineer of the Gulf, Colorado & Santa Fe Ry., with headquarters at Galveston, Tex., succeeding Mr. P. J. Carter, resigned.

Mr. C. N. Kalk, Principal Assistant Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Ry., has been promoted to be Chief Engineer, succeeding the late Thomas Greene.

Mr. C. S. Johnson, formerly Instructor in machine design at Purdue University, has been appointed Instructor in mechanical engineering at the Colorado School of Mines, Golden, Colo.

Mr. A. M. McGill, Superintendent of the Sayre, Penn., shops of the Lehigh Valley R.R., has been promoted to be Assistant Superintendent of Motive Power, with headquarters at South Bethlehem, Penn.

Mr. Hammon V. Hayes, M. Am. Inst. E. E., Consulting Engineer, Boston, Mass., has been appointed expert for the telephone companies of Great Britain in settling upon the terms of their purchase by the British Government.

Mr. Maro Johnson, Assoc. M. Am. Soc. C. E., Assistant Engineer with the Illinois Central R.R., has been appointed Assistant Engineer of Bridges of the Illinois Central R.R. and the Yazoo & Mississippi Valley R.R., with headquarters at Chicago, Ill.

Mr. C. S. Millard, M. Am. Soc. C. E., Engineer of Track and Roadway of the Cleveland, Cincinnati, Chicago & St. Louis R.R., has been appointed Superintendent of the Michigan division, succeeding Mr. S. T. Blizard, with headquarters at Wabash, Ind.

Prof. Dugald C. Jackson, Past-President Am. Inst. E. E., has been granted leave of absence from the Massachusetts Institute of Technology until Jan. 1, 1913. Prof. Jackson has been called to England in consultation over the purchase of the telephone companies by the British Government.

Mr. T. W. Evans, Superintendent of the New York Central Lines at Buffalo, N. Y., has been promoted to be General Superintendent of the Western district, with headquarters at Syracuse, N. Y., succeeding Mr. S. R. Payne, who has been promoted to be Assistant to the General Manager at New York City.

Mr. P. E. Stevens, Assoc. M. Am. Soc. C. E., formerly Assistant Bridge Engineer of the Great Northern Ry., and recently Engineer with Butler Bros., St. Paul, Minn., has been appointed Manager of the structural steel and cement departments of Morgan T. Jones & Co., Inspecting and Supervising Engineers, Chicago, Ill.

Mr. E. P. Goodwin, formerly General Superintendent of Transportation of the Chesapeake & Ohio Ry., has been appointed General Inspector of Transportation. He is succeeded as General Superintendent of Transportation by Mr. C. C. Walker, former Assistant General Manager. The office of Assistant General Manager has been abolished.

Mr. B. F. Thomas, M. Am. Soc. C. E., United States Principal Assistant Engineer, Cincinnati, Ohio, has been transferred to Frankfort, Ky., to take charge of the Kentucky river improvement, relieving Mr. W. H. McAlpine, who is transferred to the Louisville district. The work at Cincinnati on which Mr. Thomas has been engaged for several years is now practically completed.

Mr. William H. Winterrowd, Jun. Am. Soc. M. E., formerly Assistant Engineer in the mechanical department of the Lake Shore & Michigan Southern R.R., has been appointed Mechanical Engineer of the Canadian Pacific Ry., with office at Montreal, Que. Mr. Winterrowd is 28 years old and a graduate in mechanical engineering of Purdue University, class of 1907. He began his railway work as a special apprentice on the Lake Shore & Michigan Southern R. R. in 1907.

Mr. Ernst Reitler of Vienna, Austria, the Secretary-General of the International Association for Testing Materials, was tendered a dinner on Oct. 4, at the Waldorf-Astoria, in New York City, by a number of the members of the Organizing Committee which has had in charge the recent International Congress of Testing Materials that Mr. Reitler has been attending. He sailed for home on the following day. Mr. Reitler was also the guest of the Philadelphia members of the Committee at a recent dinner at the Union League Club in that city.

Mr. Austin Willard Lord, Fellow-Member of the American Institute of Architects, of New York City, has been appointed Professor and head of the department of architecture at Columbia University, New York City. Mr. Lord was born at Rolling Stone, Minn., in 1860; and after graduating from the State Normal School he studied architecture in offices at Winona, Minneapolis and St. Paul, Minn. In 1884-85 he took a special course at the Massachusetts Institute of Technology and later spent two years at

the American School in Rome, Italy. He is a member of the firm of Lord & Hewlett, Architects, of New York City.

Mr. Paul Hamilton, Engineer of Maintenance-of-Way of the Cleveland, Cincinnati, Chicago & St. Louis R.R., at Galion, Ohio, has been promoted to be Engineer of Track and Roadway, succeeding Mr. C. S. Millard, M. Am. Soc. C.E., promoted, as noted elsewhere. Mr. Joseph Mullen, Engineer of Maintenance-of-Way at Mattoon, Ill., succeeds Mr. Hamilton; Mr. W. C. Kegler, Engineer of Maintenance-of-Way at Mr. Carmel, Ill., succeeds Mr. Mullen; Mr. C. W. Cochran, Engineer of Maintenance-of-Way, at Wabash, Ind., succeeds Mr. Kegler, and Mr. A. F. Maischaider, Assistant Engineer of Maintenance-of-Way at Indianapolis, Ind., has been promoted to be Engineer of Maintenance-of-Way, succeeding Mr. Cochran.

Mr. Nathaniel A. Carle, M. Am. Inst. E. E., M. Am. Soc. C. E., formerly with the Puget Sound Bridge & Dredging Co., Seattle, Wash., has been appointed Chief Engineer of the Public Service Electric Co., of Newark, N. J., succeeding Mr. James T. Whittlesey, Assoc. Am. Inst. E. E., resigned, as noted in our issue of Aug. 8. Mr. Carle is a graduate in electrical engineering of of Leland Stanford University, Calif., and for 10 years he was connected with Westinghouse, Church, Kerr & Co., of New York City. Later he was with the Pennsylvania R.R., and for a time was engaged in hydro-electric development work in Colorado. Mr. E. B. Meyer, Assoc. Am. Inst. E. E., has been made Assistant to the Chief Engineer, and Mr. N. L. Pollard, Assoc. Am. Inst. E. E., has been appointed Electrical Engineer. Mr. S. H. Kent has been appointed Mechanical Engineer.

M. Louis Barthelemy, President of the Société des Ingenieurs Civils de France, who came to the United States last month to attend the International Congress of applied Chemistry, was the guest of honor at a subscription luncheon given at the Engineers Club, New York City, on Oct. 1. Those present at the luncheon included representatives of the principal engineering societies of the United States. The president and the secretary were present from the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Institute of Electrical Engineers. Others present included M. de Puligny, of the Mission Francaise D'Ingenieurs aux Etats-Unis, Prof. M. C. Whitaker, representing the American Chemical Society, W. H. Allen, Secretary of the American Railway Association, Dr. George F. Kunz, President of the American Scenic & Historical Preservation Society, and Mr. Robert Ridgway, a Director of the American Society of Civil Engineers and Engineer of the New York Public Service Commission. Dr. Alex C. Humphreys, President of the American Society of Mechanical Engineers, presided. Active discussion took place at the luncheon over the project for international co-operation between the principal engineering societies, American and foreign, so that one uniform card giving a member's credentials would entitle a member of any society to certain courtesies in visiting the headquarters of other societies in a foreign country.

Obituary

William Horace Corbin, Vice-President of the Joseph Dixon Crucible Company of Jersey City, N. J., died on Sept. 25. Mr. Corbin's interests and influence were widespread, including more than a dozen public-service, railway, and financial enterprises.

James H. Wise, assistant general manager of the Pacific Gas & Electric Co. of San Francisco, Calif., died at the Merritt Hospital at Oakland, Calif., on Sept. 16, following an automobile accident in which he was fatally burned by an explosion of gasoline. He was 31 years of age, and a graduate of the mining engineering course at the University of California. Mr. Wise was appointed to his position with the above mentioned company in July, 1911, and placed in entire charge of the building and extension of the company's steam and hydro-electric plants. He is survived by his mother.

Engineering Societies

COMING MEETINGS

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Oct. 15-17. Annual convention at Baltimore, Md. Secy., C. A. Lichty, 226 Jackson Blvd., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Annual meeting at Atlantic City, N. J. Secy., Geo. G. Ramsdell, 29 West 39th St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 21-25. Annual meeting at Chicago, Ill. Secy., T. A. Andreucetti, C. & N. W. Ry., Chicago, Ill.

AMERICAN ASSOCIATION FOR THE PREVENTION OF THE POLLUTION OF RIVERS AND WATERWAYS.
Oct. 23-24. Annual convention at Cleveland, Ohio. Secy., H. De B. Parsons, 22 William St., New York.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 28-31. Annual meeting at Cleveland, Ohio. Secy., Joseph Struthers, 29 W. 39th St., New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS
Nov. 12-15. Annual convention at Dallas, Texas. Secy., A. P. Folwell, 50 Union Square, New York.

RAILWAY DEVELOPMENT ASSOCIATION.
Nov. 17. Annual meeting at Cincinnati, Ohio. Secy., W. Nicholson, K. C. So. Ry., Kansas City, Mo.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 19. Annual convention at Washington, D. C. Secy., W. H. Connolly, Washington, D. C.

AMERICAN CIVIC ASSOCIATION.
Nov. 19-22. Annual convention at Baltimore, Md. Secy., Richard B. Watrous, Union Trust Bldg., Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 20. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York.

NATIONAL FOUNDERS ASSOCIATION.
Nov. 20-21. Annual convention at New York, N. Y. Secy., J. M. Taylor, 29 So. La Salle St., Chicago, Ill.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Annual meeting at New York, N. Y. Secy., D. H. Cox, 29 W. 39th St., New York.

AMERICAN MINING CONGRESS.
Nov. 25-28. Annual convention at Spokane, Wash. Secy., J. F. Callbreath, Denver, Colo.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 2-3. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Dec. 2-5. Annual meeting at Atlanta, Ga. Secy., Louis Stotz, 29 W. 39th St., New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 3-6. Annual convention at Cincinnati, Ohio. Secy., E. L. Powers, 150 Nassau St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 3-6. Annual meeting at New York City. Secy., C. W. Rice, 29 W. 39th St., New York.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 4-6. Annual meeting at Detroit, Mich. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Annual convention at Philadelphia, Penn. Secy., C. A. Prosser, 105 E. 22d St., New York.

Maine Society of Civil Engineers.—On Oct. 11-14, an inspection trip will be made to the new Aziscohos Dam on the Magalloway River, Lincoln Plantation, Maine, and a regular meeting of the society will be held at the Dam on Oct. 12.

American Society of Engineer Draftsmen.—At the annual meeting of the Society on Oct. 1, Prof. C. W. Weick, of Columbia University, was elected President for the ensuing year. A mutual benefit plan was advocated to protect members against loss through sickness, and to provide funeral expenses in case of death. The Society has quadrupled in numbers during the past year and has plans for increased activity during the coming year.

Association of Iron and Steel Electrical Engineers. At the annual meeting held at Milwaukee, Wis., Sept. 30 to Oct. 5, officers were elected as follows: President, C. W. Parkhurst, Johnstown, Penn.; Vice-Presidents, E. Friedlander, Braddock, Pa., and O. R. Jones, Youngstown, O., Secretary, James Fannington, Steubenville, Ohio.

American Road Builders Association—The 9th Annual Convention of the Association will be held at Cincinnati, Ohio, Dec. 3-6. Delegates have been appointed by the governors of several states and in connection with the exhibition of machinery, material and methods of road building, booths will be provided, showing the progress of the art in different states. Details as to the program may be obtained from the Association Secretary, E. L. Powers, 150 Nassau St., New York.

International Congress of Electroculture—The first convention will be held at Rheims, France, on Oct. 24-26, under the auspices of the French Society for Motoculture and of the Agricultural Commission of Rheims. The applications of electricity to agriculture, vitaculture, and horticulture will be discussed, and there will be an exhibition of agricultural machinery, and trials of motor-driven agricultural implements in connection with the convention.

National Electric Light Association.—The New England Section will hold its 4th Annual Convention in Boston, Mass., on Oct. 15-17, and the following are among the papers that will be presented: "The Education and Welfare of the Employee," by A. S. Nichols; "Electric 'Protective' Devices," by C. C. Badeau; "The Relation of the Central Station to the Prospective Customer," by E. M. Addis; "Transmission Line Construction," by R. D. Coombs, and "The Development and Application of Electricity to Agriculture," by C. H. Miles. Particulars concerning the program and accomodations may be obtained from the Section secretary, Miss O. A. Bursiel, 149 Fremont St., Boston, Mass.